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The implications of cybernetic command and control systems on the Navy Fleet Commander.

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THE IMPLICATIONS OF CYBERNETIC COMMAND AND CONTROL SYSTEMS ON THE NAVY FLEET COMMANDER

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THE IMPLICATIONS OF CYBERNETIC COMMAND AND CONTROL SYSTEMS ON THE NAVY FLEET COMMANDER

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TABLE OF CONTENTS

TABLE OF CONTENTS

Chapter Page

LIST OF ILLUSTRATIONS

CHAPTER I

INTRODUCTION

The Importance of the Problem

The U. S. Navy has embarked upon a technological revolution. Some have called it a computer revolution, others a nuclear revolution, and still others a technological revolution. The progress in this revolution has been greater than the transition from sail to steam, from cannonball to armour-piercing projectile, or from steam to nuclear power. Mr. Ralph J. Cordiner, when President of the General Electric Company, described this revolution when he testified before a Congressional subcommittee on automation, in the following words:

> When the history of our age is written, I think it will record three profoundly important technological developments:
>
> Nuclear energy, which tremendously increases the amount of energy available to do the world's work;
>
> Automation, which multiplies man's ability to use tools;
>
> And computers, which multiply man's ability to do mental work.
>
> Some of our engineers believe that of these three, the computer will bring the greatest benefit to man.[1]

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[1]Ralph J. Cordiner, Subcommittee on Economic Stabilization of the Joint Committee on the Economic Report. (Washington: Government Printing Office, 1955), p. 44.

The technological progress of this era has presented the Navy and its Commanders of today with a new set of problems. One of the major problems is the management and control of our military forces at a time when devastation can be hurled halfway across the earth in a matter of minutes. At this time, our military forces cannot afford for a button to be pushed or left unpushed--in error.

As pointed out by Admiral Claude Ricketts:

> We must be capable of responding quickly and effectively to military aggression short of general war. We cannot predict, with assured accuracy, the area, the time, or the circumstances of such aggression. We must be ready to handle it wherever, whenever, or however it may come.[2]

During this advancing technological revolution, increased emphasis has been placed on the introduction of new equipment into Navy fleet operations. These new weapons, aircraft, and support systems entering the fleets today and in various stages of development for fleets tomorrow defy description, and it has all taken place in the last 20 years.

Perhaps the most important advance of this decade was the introduction of the computer into the naval operational environment. Naval planning includes even more automation for the future. Vice Admiral William F. Raborn, USN, expressed his views on automation

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[2]Claude Ricketts, Admiral, USN, "Naval Power--Present and Future," U. S. Naval Institute Proceedings, (January, 1963), p. 33.

in a recent U. S. Naval Institute Proceedings as follows:

> The internal control of ships will approach those of the airplane. One man will be able to control the maneuvering capability as well as the armament of an entire ship.[3]

The military approach during this age has been concerned primarily with physical equipment. However, the Navy must be practical; it must be able to use these new capabilities effectively. The Navy must consider a factor which is just as vital, but apparently not as pretentious as the new equipment, and this factor is the "Navy man." For the purpose of this paper, the "Navy man" is the Fleet Commander. The time has come for all military forces to heed the warning signs on the horizon. If these signs are not given proper consideration, who will manage and control our forces when the allowance time for the decision process approaches zero?

The Problem

The purpose of this study is to determine the implications on and the importance to the Fleet Commander and his staff of Cybernetic Command and Control Systems.

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[3]William F. Raborn, Vice Admiral, USN, "New Horizons of Naval Research and Development," U. S. Naval Institute Proceedings (January, 1963), p. 42.

The Approach to the Problem

The Fleet Commander's staff, its responsibilities, organization and decision-making process will be examined to determine the major effects and changes because of the introduction of Cybernetic Command and Control Systems into the Fleet Commander's operational environment.

Non-military information processing, management information systems, and decision-making processes will be analyzed to develop management implications because of the introduction of cybernetics into the world of business and industry.

In turn, military and non-military implications will be compared to study which areas and to what degree each has affected the other.

The Task Fleet Commander and his staff was selected as the area of research since it is the largest combat operational unit within the Naval Organization. Therefore, the impact of cybernetics in the fleet environment should affect the Fleet Commander and his staff with greater emphasis than other staff and operational commands in the combatant Navy.

Review of Literature

Literature on command control, cybernetics, and management is plentiful. The technology and state of the art in automation is advancing so rapidly that it is impossible to remain current on

all the latest improvements. Most of the information written on the implications of command and control centers on the national level, merely touches the operational phases. The trade magazines specializing in computers, electronic data processing systems and the management of these systems are more useful than books in keeping up to date.

The following sources were reviewed:

1. Government, military and commercial technical, industry and management periodicals from 1955 to date.

2. Available technical research reports on the subject.

3. The most recent books on computers, automatic data processing, management, decision-making and Navy staff systems, which are listed in the bibliography.

Semantics in Command and Control Terms

In the research for this paper, semantics problems arose over the definition of such words as automation, computers, automatic data processing and other related terms. For example, in regard to the nature and use of computers and automation, there are two important classes of devices:

1. Usually referred to when one speaks of automation are devices that automatically perform sensing and motor tasks, replacing or improving on human capacities for performing these functions.

2. Usually referred to when one speaks of computers are devices that perform, very rapidly, information processing and routine or complex logical and decision-making tasks, replacing or improving on human capacities for performing these functions.

In command and control and in business these two devices overlap. Therefore, to eliminate the awkwardness of repeating the words "automation" and "computers" each time, the paper refers to both at the same time; and to avoid semantic difficulties involved in using one term or the other, the terms "cybernetic," "cybernation" or "cybernetics" will be used to refer to both "automation" and "computers." The terms are legitimate to the extent that they are derivatives of "cybernetics," a term invented by Norbert Wiener to mean the process of communication and control in man and machines. The theory and practice of cybernetics underlie all systematic design and application of automation and computers.[4]

Organization of the Study

To determine the implications of Cybernetic Command and Control Systems on the Fleet Commander, the following questions must be answered:

1. What is the job of the Fleet Commander and his staff in the Navy operational environment before and after cybernetics?

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[4]Morris Philipson (ed.). Automation: Implications for the Future (New York: Vintage Books, 1962), p. 126.

2. What is a Cybernetic Command and Control System, and what is the role of the Fleet Commander in this system?

3. What are the implications of cybernetics on non-military management and what analogies can be drawn between military and non-military implications?

CHAPTER II

GENERAL BACKGROUND

The Task Fleet Organization

To place the role of the Fleet Commander in the proper perspective, it is mandatory to review the place of the Task Fleet within the Department of the Navy organization. The Task Fleet concept was developed during World War II and is the largest operational element within the Navy organization framework developed for managing the Navy's combatant ships and aircraft. Broadly speaking, the "Fleet" may be taken as the largest organizational element that comes in direct contact with the enemy in the performance of combat missions.[1] This naval organization was devised to take advantage of the mobility and freedom of action that the sea and air afford to ships and aircraft in fast moving, modern warfare.[2]

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[1]John R. Beishline, Military Management for National Defense (New York: Prentice Hall, Inc., 1950), p. 29.

[2]John D. Hayes, Rear Admiral, USN, "The Navy's Task Force," Ordinance, (November-December, 1957), p. 39.

Forces of fleet size are assigned ships depending on the mission involved. Ship types that could be assigned are carriers, cruisers, destroyers and submarines. Other components which could be assigned include Air Wings, and Service, Amphibious and Fleet Marine forces.

Fleet Commander and His Staff

For operational direction or mission assignment the Fleet Commander's chain of command runs from the President to the Secretary of Defense and through Joint Chiefs of Staff and Unified Commander to the Fleet Commander down to his subordinate commanders. The chain of command for purposes other than operational direction of fleet forces runs from the President to the Secretary of Defense through the Secretary of the Navy, the Chief of Naval Operations, the Unified Commander to the Fleet Commander and then to his subordinate commanders. This chain embraces the training and readiness of military forces plus their administration and support.[3]

Within the Navy chain of command, the Fleet Commander's function is to authoritatively and effectively control and direct the forces assigned him in the successful accomplishment of his

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[3]U. S. Navy, The Department of the Navy: A Description of its Functional Organization, NAVEXOS P-435, (Washington: U. S. Government Printing Office, 1962), p. 1.

assigned missions.[4] Simply stated, the Commander's primary function is command. There are a number of details inherent in large organizations which make it impossible for the Commander to accomplish his primary function of command. Therefore, the commander must have a reasonable number of assistants to whom these details can be intrusted. The staff must furnish the commander all the necessary assistance so he may perform his function of command effectively and make knowledgeable decisions.

The functions of the Fleet Commander's staff are as follows:

1. Provide information.
2. Anticipatory planning.
3. Recommendations for plans and orders.
4. Preparation of directives.
5. Supervise and evaluate.[5]

The first task of the staff is to "provide information" which supplies the basis for the sound military decision. Information on own and enemy forces plus other pertinent matters must be obtained from every source, evaluated, and analyzed to insure that it is sufficiently detailed and accurate for the

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[4]S. S. Miller, Captain, USN, "Naval Staffs," Naval War College Review, (January, 1952), p. 2.

[5]Ibid., p. 3.

Commander to make sound strategic, tactical and logistic decisions. This information must disseminate to all friendly commands who need to know, both vertically and horizontally in the organization as well as completely within the staff to insure coordinated staff action.

The second point "anticipatory planning" concerns making a continuous study of the situation and preparing plans for possible future contingencies in the fields of strategy, tactics and logistics.

"Recommendations for plans and orders" is based on the particular mission of the Commander as well as directives from higher authority.

The fourth task is to translate the Commander's decisions into directives. This function includes the transmission of such directives to the properly designated recipients.

The fifth function is to supervise and evaluate as authorized by the Commander. Here certain designated members of the staff supervise the execution of plans and orders, and take such action as necessary, always in the name of the Commander, to insure the Commander's intentions are carried out. Evaluating concerns results of planned action in order to apply lessons learned to future planning.[6]

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[6] *Ibid.*, p. 4.

The general functions of the Fleet Commander may be divided as follows:

1. Operational--which lead directly to accomplishment of the mission.

2. Supporting--permitting success of number one above.

Supporting functions include physically building up and maintaining the quantity of men and material of the command to a point of adequate quantitative combat readiness; preparation of forces, men and material, to a point of adequate qualitative combat readiness, and maintenance of that condition; service for the human and material requirements of the command, and maintenance of the good condition of the personnel and material of the command.[7]

The method of executing the processes of command vary with commanders. In the Navy these processes are much more flexible than in other military organizations. Primarily, Fleet Commanders follow the below listed divisional areas in executing command processes:

1. Administration.
2. Intelligence.
3. Operations and plans.
4. Logistics.
5. Communications.

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[7] Ibid., p. 6.

For example, the operational functions leading directly to the accomplishment of the mission link directly to administration which handles quantity of personnel, records, control and morale; intelligence which provides information of enemy forces and other tangible and intangible elements bearing directly and indirectly on the achievement of the Commander's mission; operations which prepares plans, organizes, trains personnel and provides intelligence on own forces; communications which provides rapid means for direction of forces for the Commander and keeps other interested commands advised on what they need to know.

In the supporting functions all five functional divisions work together in providing adequate quantitative and qualitative combat readiness, particularly with operations in respect to training of personnel. Also, logistics and communications provide support in regard to materiel.[8]

The Fleet Commander does not have a standard staff organization and in the past has not trained officers specifically for naval staff duties other than training gained by experience. Navy operational commanders are given wide latitude in organization of their staffs. Prior to the advent of the technological revolution, there were very few specialists in a sea-going staff. Also the size of the commander's staff could be

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[8] Ibid., p. 7.

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[8] Ibid., p. 7.

influenced by space limitations aboard ship. When insufficient space is a factor, the principal administrative and logistic functions of the staff may be performed largely by a rear echelon, thereby keeping such functions at a minimum on the operating staff. So the Fleet Commander's staff could be separated into two components: operational and administrative; wherein the administrative portion is minimized when actually in combat areas. Of course, since naval staffs are flexible, the Fleet Commander could take his whole staff aboard the flagship.

In the Fleet Commander's case, a certain degree of unofficial standardization in staff organization has developed.[9] Commander Second Fleet's staff organization is shown in Figure 1. His staff, organized to meet his particular requirements, is divided into four staff sections or divisions. Each division is administered by the first-mentioned officer in the division. This organization provides for logistics billets in both the Operations and Plans Divisions; intelligence is handled within the Plans Division. Note that several billets are common to the Operations and Plans Divisions.[10]

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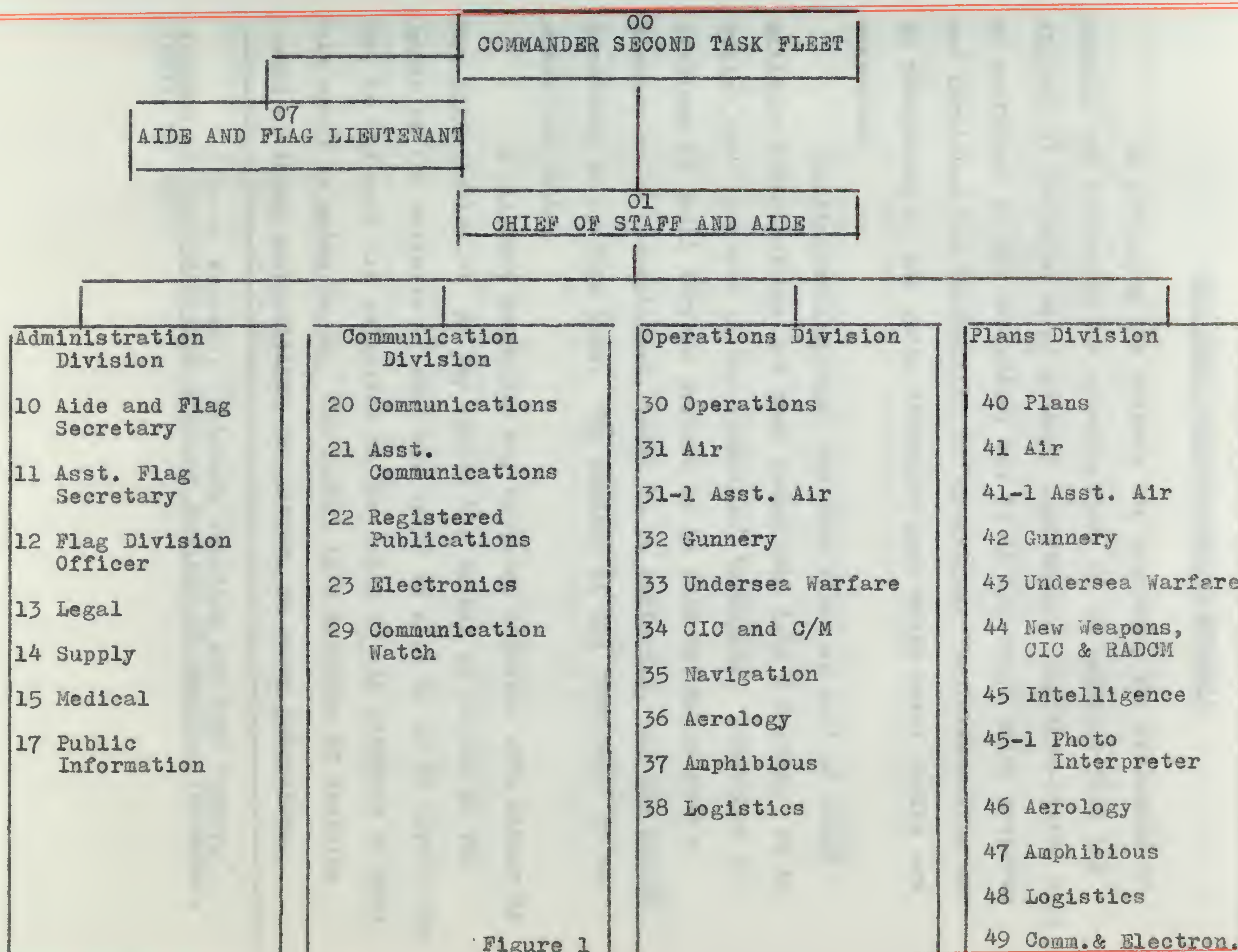
[9]The United States Naval War College, Staff Systems Command and Staff Department, (October, 1952), pp. 18-20.

[10]*Ibid*., p. 21.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COMMANDER SECOND TASK FLEET
07
AIDE AND FLAG LIEUTENANT
01
CHIEF OF STAFF AND AIDE
Administration Division
10 Aide and Flag Secretary
11 Asst. Flag Secretary
12 Flag Division Officer
13 Legal
14 Supply
15 Medical
17 Public Information
Communication Division
20 Communications
21 Asst. Communications
22 Registered Publications
23 Electronics
29 Communication Watch
Operations Division
30 Operations
31 Air
31-1 Asst. Air
32 Gunnery
33 Undersea Warfare
34 CIC and C/M
35 Navigation
36 Aerology
37 Amphibious
38 Logistics
Plans Division
40 Plans
41 Air
41-1 Asst. Air
42 Gunnery
43 Undersea Warfare
44 New Weapons, CIC & RADCM
45 Intelligence
45-1 Photo Interpreter
46 Aerology
47 Amphibious
48 Logistics
49 Comm.& Electron.

Figure 1

The Navy Decision-Making Process

In reviewing the methods for executing the processes of command and analyzing the organization, it is apparent that the element of decision is of primary importance. Decision-making will be performed by the Commander, but it is his staff which prepares and furnishes the information for decisions. Decision-making may be recognized as the basic structure upon which naval staffs are organized.

Decision-making under the Task Fleet as well as other military organizations has been formalized into a system. It is called the "estimate of the situation" technique. Solutions to problems of Naval Warfare arrived at by this technique give a mission to be accomplished, tasks to be performed, and the forces necessary to perform them. The product of the "estimate" is an operation plan.

A military commander may approach decision with either of two philosophies.[11] He may select his course of action on the basis of his estimate of what his enemy is able to do to oppose him. Or, he may make his selection on the basis of his estimate of what his enemy is going to do. The former is a doctrine of decision based on enemy capabilities; the latter, on enemy intentions.

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[11] O. G. Haywood, "Military Decision and Game Theory," Journal of the Operations Research Society of America, (November, 1954), p. 365.

The doctrine of decision of the Naval Fleet Commander is a doctrine based on enemy capabilities. The Commander is enjoined to select the course of action which offers the promise of success in view of the enemy capabilities.[12]

The process of decision, as approved by the Joint Chiefs of Staff is formalized in a five-step analysis. These steps are as follows:

1. Determination of the mission.
2. Description of the situation and courses of action.
3. Analysis of opposing courses of action.
4. Comparison of own courses of action.
5. The decision.[13]

Although the Fleet Commander follows these steps in making a decision, it must be noted that when he makes a decision an intangible element known as military judgment is used, just as business decisions are made with business judgment.[14]

The word "decision" implies choice, a resolution among alternatives. The principal prerequisite for a decision is the definition of alternatives in a form that will cause the decision

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[12] Ibid., p. 366.

[13] John McDonald, "How Executives Make Decisions," The Executive Life, ed. Editors of Fortune (Garden City, N. Y.: Doubleday and Co., Inc., 1956), p. 167.

[14] Ibid.

maker to exercise his power of judgment in resolving them. The staff assembles all the pertinent facts, orders them so as to define the alternatives they imply, rules out those alternatives that are clearly infeasible or precluded by existing policy or other mandatory constraints, and presents those remaining to the Commander for resolution--a decision. This familiar staff process accounts for much of the information that flows into the staff organization and is stowed away, searched out, assembled, and reassembled in the decision-making process.

Usually no matter how thoroughly and carefully the alternatives are defined, the Fleet Commander is seldom satisfied the first time around. By some subtle, subjective process compounded by experience and the mysterious working of the faculty of human judgment, the Commander will ferret out some overlooked fact or point out some different ordering of the facts, so the process must be done again. Or, by this same ill-defined process, the Commander will reach what proves to be the right decision for a particular case when the right decision was not one of the alternatives presented.[15]

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[15]John A. Chastain, "Who is in Command: Commander or Computer"?, Naval Review (Menosha, Wisconsin: George Banta Co., 1963), p. 41.

CHAPTER III

CYBERNETIC COMMAND AND CONTROL

A Brief History of Command and Control

Before presenting a brief history, it would be worthwhile to define command and control in the military command environment today. The standard military definition for command and control is: An arrangement of personnel, facilities and the means for information acquisition, processing, and dissemination employed by a Commander in planning, directing and controlling operations.[1]

Command and control is not new. Military commanders have always devised organizations and methods to secure knowledge needed to make informed decisions and issue commands.

In the early days of the Navy, the Commander carried most of his battle plan in his head. He had a small staff, if any at all, but in a sense was still organized for command and control. Contacts with his superiors might have been days or even weeks apart. Battle and even wars were sometimes won or lost before the first hint of the start of battle reached heads of governments.

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[1] Clifton L. Nicholson, Lt. Col., USAF, "Command and Control and Decision-Making Process," <u>Air University Review</u> (November-December, 1963), p. 77.

An early illustration of command and control is the coast watchers who sighted the armada from the English Channel cliffs and were as much part of Sir Francis Drake's command control methods as today's radar or intercept equipment is part of the ultra-modern Navy command and control system.[2]

There are many examples of battles where today's concept of command and control would have been useful. News of Admiral Dewey's victory in Manila did not reach Washington for a number of days. Also on December 7, 1941, when Pearl Harbor received a surprise attack, Admiral Kimmel and General Short had no communications with Washington.[3]

The decisive victories in battle have been marked by great advantages gained or lost by command and control of forces more often than by superior force itself, leaving little doubt that the lessons of history in all ages define the first duty of command as establishment of the means of command.

In World War II the Combat Information Center was created to provide the commander with the means for command and decision. This system collected, correlated, displayed and evaluated combat information for decision-making purposes. The commander was able

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[2]Fred W. Kittler, Captain, USN, "Command Control--The Navy's Link to Global Strategy," Naval Engineers Journal (February, 1963), p. 31.

[3]Austin M. Porter, Cdr., USN, "Command and Control," Naval Engineers Journal, (February, 1963), p. 28.

to see things happening through the information provided by the Combat Information Center. Still the conduct of the battle moved too fast, even then, for him to hear and see all that was transpiring in a tactical situation. So, even in World War II, there was a great need for improved command and control systems.

Today, as a new technological revolution is moving into the military environment, the command and control systems have become a necessity.

The Need for Cybernetic Command and Control

The technological progress of this era has presented the nation as well as the Fleet Commander with an extraordinarily different requirement for facts as compared to those necessary during World War II or Drake's day. The advent of the long-range missile, the atomic weapon and the jet aircraft have, by their very nature placed an emphasis upon the need for Cybernetic Command and Control Systems to provide the necessary information for decision-making. The question arises why the strong emphasis on command and control systems?

The need for Cybernetic Command and Control Systems can be categorized into two primary areas: "time to react" and "alternate choices."

By "time to react," the inference is to the problem of attack. In the early days the nation and the Fleet Commander wanted to be informed within two days of any significant event around the

world--then $2\frac{1}{2}$ hours--then 20 minutes warning time. Now the time is approaching zero.[4]

Factors contributing to reduction in "time to react" include the following:

1. The emergence of the intercontinental ballistic missile as the primary punch of global war. This missile poses serious threats to the nation, such as the time in which the nation has to react, and the unimaginable, terrible consequences if the information of a missile attack by an aggressor were wrong.[5]

2. The development of the jet aircraft and atomic weapons have reduced the time factor and pointed out the need for command and control on both the National and Fleet Commander's level of operations. The nation must be capable of deterring nuclear war, and if that fails, to win a nuclear war.[6]

In "alternate choices," the United States defense capability must provide the President a choice between alternate courses of action--not just surrender or global nuclear war. The "alternate choice" need has forced command and control experts to

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[4]David F. Seaman, Captain, USN, "Intelligence in the Fleet," Naval Engineers Journal (February, 1963), p. 61.

[5]"The Search for Effective Command and Control," Armed Forces Management (July, 1962), p. 19.

[6]Ibid.

devise systems that are sophisticated, as well as have the capability of handling more factors.[7]

The politico-military objectives of the United States further point out the necessity of command and control. The major politico-military objectives have been stated as follows:

> 1. To deter any attack, whether conventional or nuclear, upon our territories, and upon those of our allies, and to defend these territories when and if they are attacked.
> 2. With the failure of deterrent action, to endeavor to contain over-all damage and to emerge, ultimately, the victor in the struggle, after the appropriate military action has been taken.
> 3. To assist in the strengthening of the Free World against the Communist menace and its plan for global domination.[8]

The politico-military situation prevents establishing firm objectives for military commanders to use in contingency planning.[9] Rather, it places emphasis on the ability to keep planning flexible to an unprecedented degree and to be able to do detailed planning very rapidly. Because of the necessity of keeping our forces deployed continuously in a variety of trouble spots in what nominally is a time of peace, this situation contains political and diplomatic, as well as military factors. The Cuban experience is an example.

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[7] Ibid.

[8] John T. Hayward, Vice Admiral, USN, "Command and Control in the Nuclear Age," U. S. Naval Institute Proceedings (November, 1963), p. 41.

[9] Chastain, p. 33.

The constraints on the military commander in planning, in exercising, and in employing his forces, require command and control means that will permit decisions to be monitored, or participated in, by higher commands in much greater detail than ever before, and this must be accomplished without any significant delay in the decision-making process.[10]

Command and Control Systems

A command and control system is a composite of equipment, skills, and techniques which are capable of performing clearly defined functions enabling a commander to exercise continuous control of his forces and weapons in all situations by providing him with the information needed to make operational decisions and the means for disseminating these decisions.[11] A complete system includes all sub-systems, related facilities, equipments, services, and personnel required for operation of the system so that it can be considered a self-sufficient unit in its operational environment.

Information processing in command and control systems is the processing of information in direct support of the command decision process. Therefore, included are personnel, weapons, logistic and sensor systems needed in the command process while not being principally concerned with them. Second, it is the direct

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[10] *Ibid.*

[11] Nicholson, p. 77.

control of weapons or sensor systems, i.e., radar, radio, receivers. Third, the subject involves the data processing need to supply information to the Commander and his staff, therefore, one of the most salient characteristics of such systems is that they have man/machine complex.[12]

The man/machine complex refers to the concept of the relationship needed between the Commander and the equipment. The principle of man and machine will be discussed further in this study.

Cybernetic Command and Control Systems refer to systems which have a general purpose digital type computer with "real-time" and "on-line" operation capabilities. To further understand the concept of Cybernetic Command and Control Systems, it is necessary to define "real-time" and "on-line." Richard E. Sprauge defines these terms as follows:

> In a total on-line and real-time system each and every person, machine or point in the organization using the system, having a true requirement to originate, retrieve or utilize information, is provided a point-of-origin device. These devices are connected to a central data processing complex by wire or other direct communications links. Each device permits two-directional information flow at a point of origin of information such that the person or machine using it receives responses to his requests in the amount of time desired.[13]

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[12]Walter F. Bauer, "Military Command: A Challenge for Information Processing," Computers and Automation (April, 1963), p. 9.

[13]Richard E. Sprauge, Electronic Business Systems: Management Use of On-Line--Real-Time Computers (New York: Roland Press Company, 1962), p. 5.

A general definition found in data processing glossaries defines "real-time" as "the performance of a computation during the actual time that the related physical process transpires in order that the results of the compilation are useful in guiding the physical process,"[14] or "the processing of information or data in a sufficiently rapid manner so the results of the processing are available in time to influence the process being monitored or controlled."[15]

The computers used in Cybernetic Command and Control Systems have large-scale storage and data processing capability and wide ranging flexible information request devices. The system is capable of accepting revision, restraints and parameters by the Fleet Commander so he may derive workable solutions in his decision-making process.

The elements of a Navy type Cybernetic Command and Control System are as follows:

1. Sensors, i.e., radars and sonars.

2. Data storage and processing equipments, i.e., computers, primary systems and sub-systems.

3. Input and output equipments, i.e., printing machines or displays.

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[14]"A Data Communication Glossary," Datamation (March, 1962), p. 72.

[15]Executive Office of the President, Bureau of the Budget, Automatic Data Processing Glossary (Washington: U. S. Government Printing Office, 1962), p. 41.

4. Communication links, i.e., links which permit transfer of data from remote sensors, control forces and distant weapons.

5. The human element, i.e., from equipment operators to Fleet Commanders who utilize the whole system in making decisions.[16]

Colonel C. J. Davis, U. S. Army, in his article "Command Control and Cybernetics" defined the elements of a cybernetic system as "sensing, collecting, processing and displaying components."[17] Both of these definitions are correct; it is a matter of degree, the first more inclusive than the latter. For purposes of this paper the first definition will be used since it refers specifically to the Navy type system.

The Status of Command and Control Systems Today

The status of command and control systems in this changing technological age is very difficult without getting into the military security picture. Since this paper does not intend to get into the classified area, the status of Navy command and control systems will be demonstrated by giving brief summarizations of unclassified systems in use and in the planning stages.

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[16] Fred W. Kittler, "Command Control--The Navy's Link to Global Strategy," Naval Engineers Journal (February, 1963), p. 32.

[17] C. J. Davis, Colonel, U. S. Army, "Command Control and Cybernetics," Army (January, 1963), p. 51.

The Naval Tactical Data System

The Naval Tactical Data System (NTDS) is a system which is installed and operating in the fleet today. It is a shipboard system designed to enable a ship to handle tactical information more rapidly and efficiently than was previously possible. This system operates in real-time, is on-line and consists of both men and equipment.[18]

This equipment receives inputs from sensing devices, processes the data into a usable form, makes routine calculations, then communicates the required information to the men in the system, and assists in executing orders made by the Commander and other men in the system. The system also provides for the rapid communication of combat information between ships.

This man/machine complex provides communications both internal and external to a ship. Computers and display consoles talk to each other on a particular ship and between ships in the task fleet. Each ship is thus given the ability to act faster, more accurately, and with greater reliability in combat situations. Further, the task fleet as a whole has a greater capability.[19]

The Naval Tactical Data System furnishes the Fleet Commander with a series of alternate recommendations on the weapons which should be used against the enemy. The Commander may accept

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[18] E. G. Svendsen, Captain, USN, "Naval Tactical Data System," Sperryscope, XV (Third Quarter, 1961), p. 2.

[19] Ibid.

the recommendations made by the system, or may make another decision based on his own judgment. In either event, the system stands ready to transmit orders to his own fire control center or to the ships and the aircraft which will participate in the attack.

The computer used in the Naval Tactical Data System is described technically as "a general purpose, stored-program machine with a very high speed, random access memory containing one million bits of information."[20]

For comparison this equipment simulates a large business system with strategically located division offices (ships), all bound together by an information and control network. The complete network, in effect, not only keeps the home office (Fleet Commander) instantaneously aware of regional and system fluctuation in sales, costs, inventories and profits, but takes the necessary steps to correct imbalances.[21]

The Marine Tactical Data System

The Marine Tactical Data System (MTDS) uses a modular, integrated hut concept which can be transported by helicopter, transport aircraft or truck. This complex will allow Marines, when making a landing, to track enemy aircraft by radar and to assign

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[20]Paul Conlin, "Combat Computer Boots Navy's Sea Punch," Armed Forces Management (July, 1961), p. 15.

[21]Gilbert Burck, "The Boundless Age of the Computer," Fortune (March, 1964), p. 108.

controlled interceptors and antiaircraft missile batteries with the aid of high speed computations by digital computers. The equipment permits integrated air defense, close air support, enroute air traffic control and control of surface to air missiles to be established within a short time.[22] The Marine Tactical Data System would be used with the Naval Tactical Data System when the Fleet Commander's mission was to acquire enemy real estate through an amphibious landing.

<u>Problem Areas in Development of Command and Control Systems</u>

The problem areas in the development of command and control systems include the three primary categories listed below:

1. Communication problems.
2. Problems in data handling.
3. Problems in requirements.

Communication Problems

First, the importance of the communication problem in command and control has been pointed out by Dr. Robert Pfefferkorn of Martin Company, when he said: "A Command and Control System is a

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[22]"Marine Tactical Data System," <u>ADP Service Newsletter</u> (February, 1962), p. 3.

communication system."[23] It is noted that the C^3 principle advocating the inseparability of communications, command and control is becoming widely accepted in the command and control field. The Fleet Commander would be unable to function effectively without reliability and survivability in all phases of his communications.[24] The solution to this problem centers on the development of survivable communications through hardening, dispersal and redundancy. Survivable communications means communication across the entire spectrum of the art, including applications of VHF and microwave systems, broad-band cable, HF, Iono- and Trophospheric-scatter, UHF and communication satellites, as well as rocket communication systems. Satisfactory progress is being made in research and development which indicates that this overall problem will be solved in the near future. Communications have developed to the point today where control is possible from any location and is not limited to physical proximity to the fighting force.[25] Also, through development in micro-electronics, size and weight of

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[23]Robert G. Pfefferkorn, "Taylor's Flexible Response Strategy Shifts Command and Control Perspective," Armed Forces Management (July, 1963), p. 34.

[24]C. W. Burklund, "National Military Command and Control," Armed Forces Management, (July, 1963), p. 20.

[25]Verden McQueen, Lt. Col, USAF, "Total Command and Control through Computers," Armed Forces Management, (July, 1963), p. 26.

equipment are being reduced and reliability and survivability are being increased.[26] Today it appears the solution to communication problems has advanced further than many of the other problem areas.[27]

Problems in Data Handling

Second, the data handling problems cover three primary areas which are significant enough to warrant attention. These areas include:

1. Standardization and improvement of the computer and associated equipments (hardware).
2. Improvement and standardization of software.
3. Development of close relationship of man and machine.

In reference to the standardization and improvement of the computer system there is a need for improvement in the performance capabilities of storage devices such as disc files, and for development of more rapid peripheral access to and from the central computer. For example, an optical reader is needed to provide for direct input of hard copy.

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[26] Charles T. Garland, "Naval Communications Today and for the World of Multi-megaton Weapons," Naval Engineers Journal, (February, 1963), p. 39.

[27] Burklund, p. 20.

Computers must fit better into the environment of the Navy shipboard installation. They are adequate functionally, and speedwise, but cannot cope properly with the Navy environment because of their size. The weakest link in the Navy Command and Control System is the display area.[28] There is a lack of automated display for the information fed into the sea-arm system. The development of miniaturized equipment is considered an answer to the environment problem. Progress in this area has been satisfactory and will meet the Fleet Commander's needs in ten years. Although there is room for standardization and improvement of computers and associated equipment, the present rate of progress of basic computer characteristics--logic, design, speed, capacity--is satisfactory. The needs of today are being met, and the needs of tomorrow will be met if the present rate of progress continues.[29]

The computer programming for command and control of the future is difficult because of the scope and magnitude of processing requirements and the need for accelerated development. Considerable progress is being made in computer program production. There is a better understanding of the management and development aspects as well as a continuing development and an increasing

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[28]"The Naval Tactical Data System: We Have More Than 800 Command and Control Systems," Armed Forces Management, (July, 1963), pp. 44-45.

[29]"Where the Computer Fits in Command and Control," Armed Forces Management, (July, 1962), p. 22.

acceptance of procedure oriented languages. Also, there have been improved compilers, and studies have been made on the more efficient utilization of computers for program production and checkout.[30]

Computer technology has developed so fast that the programming and designing elements in the command and control area have not been able to keep pace.[31] Strategic and tactical problems must be analyzed and systems devised before equipment can be properly developed. The development of operational designs and programs is a difficult task, and when accomplished, the systems phase will be improved.

The major Navy improvement of late has been in programming. Several hundred programming projects have been developed and 50% have been analyzed, with a number completed.[32] Considerable programming additions have been made in the fields of intelligence and logistics also.

Another problem area of data handling is the need for the development of a closer relationship between man and machine. In this area one of the main problems is the translation of the subtle

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[30] "The Search for Effective Command and Control," Armed Forces Management, (July, 1962), p. 19.

[31] Ibid., p. 20.

[32] "The Naval Tactical Data System: We Have More than 800 Command and Control Systems," Armed Forces Management, (July, 1963), pp. 44-45.

innuendoes of force operations into concrete formats which a computer can use.[33] It is a problem of identifying bits of information which, when synthesized, will reveal significant trends. There has been increased emphasis placed on the man/machine concept by all services.[34] An increasing understanding of decision-making as a man/machine process and other developments leading to technological improvements are receiving top priority attention by the experts in command and control.

Languages have always been a problem in command and control. Many command and control failures in the past can be traced to failure in distinguishing between a plan and an order, or an order and a command.[35] Computers have introduced even newer language. Automated systems involve the use of programming language and machine computer. Unfortunately these new languages consist of a wide variety of tongues and dialects. Only recently has it become apparent that problems such as inter- and intra-system compatibility are mainly language.[36] If language is to convey information from one component of a system to another, it must be "understood" by the receiver. If it isn't, a converter or a translator is needed.

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[33]McQueen, p. 26.

[34]Bauer, p. 11.

[35]"Where the Computer Fits in Command and Control," Armed Forces Management, (July, 1962), p. 22.

[36]Ibid., p. 23.

The Department of Defense is now working in the area of standardization of languages--the assumption is that the language adopted should be the same as that used by the business community. One reason difficulties have arisen is that programming languages at their present level has probably just become ready for standardization.[37]

Problems in Requirements

The third and final major problem area in development of command and control is requirements. Educating Navy commanders to computer technology and assuring that those who make command and who control machinery know intimately the requirements and needs of the specific commander will be a giant step in the right direction. To go further, the determination of what the military requirements of system really are needs to be answered. What does the commander really need to know? What information is of real value and not merely interesting background?[38] One difficulty has been in finding military men who know enough about computer technology to link the machine to combat operations.

Essential to the design of a command and control system is teamwork between military strategists and technicians. Each must know intimately the needs of the other.

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[37] *Ibid.*

[38] "The Search for Effective Command and Control," *Armed Forces Management*, (July, 1962), p. 19.

In an interview with an authority in the Chief of Naval Operations' Command and Control Office, it was pointed out that "great strides have been made in the last year in regard to the requirements aspect of command and control. Commanders and technicians are beginning to see the problems and are working closer together."[39]

There is no question that problems confronting the experts in command and control will be large in the years ahead, but they also insist that these problems can be solved. Future improvements, according to these experts, will not be great leaps forward, but modest improvements which will meet the needs of Naval commanders.[40]

The national level of development is in the formative state, but on the unified and specified command and service level considerable progress has been made--development of L' systems in the Air Force and the Naval Tactical Data Systems in the Navy illustrate that complete control through computer analysis is possible within the next few years.[41] Both these systems have been operational for some time and results obtained have been beyond the expectations of the Air Force and the Navy.

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[39]Interview with Assistant to Naval Command and Control Executive in the Office of Deputy Chief of Naval Operations, October 24, 1963.

[40]"The Search for Effective Command and Control," Armed Forces Management, (July, 1962), p. 19.

[41]*Ibid.*

With the bright outlook for solution to the major problem areas, future controllable forces provided by the armed services will be possible; uncontrollable forces will be phased out.[42]

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[42]Austin M. Porter, "Command and Control," Naval Engineers Journal, (February, 1963), p. 27.

CHAPTER IV

THE IMPLICATIONS OF INFORMATION TECHNOLOGY ON NONMILITARY MANAGEMENT

Information Technology and Management Information Systems

Over the last decade a new technology, called information technology has begun to take hold in American business, so new that it is difficult to evaluate. Many aspects of this new technology are uncertain, but it has moved into the business managerial scene rapidly, with definite far-reaching impact on the managerial organization and managerial decision-making. As discussed previously, at the same time but at a much more rapid rate, this technology has moved into the military activities and changed, as well as improved command and managerial processes.

Information technology has several related parts. Primarily it consists of the techniques of processing large amounts of information rapidly for managerial purposes and is epitomized by the high-speed computer.[1] Other parts of this technology include

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[1]Harold J. Leavitt and Thomas L. Whisler, "Management in the 1980's," Harvard Business Review, (November-December, 1958), p. 44.

the application of statistical and mathematical methods to decision-making problems and the simulation of higher thinking through computer programs.

This study is primarily interested in the information processing aspect of the new technology, and management information and real-time, on-line business systems which are similar to Cybernetic Command and Control Systems.

Management information systems are defined as communication process in which data are recorded and processed for operational purposes.[2] The problems are isolated for higher level decision-making and information is fed back to top management to reflect progress or lack of progress in achieving major objectives. These systems are built around the power of a large scale electronic computer, as is Navy command and control system, and involve huge storage capacities, immediate accessibility to stored data, and input/output hardware to efficiently retrieve data. Major effort lately in developing these systems has been in the areas of storage and retrieval of large masses of data. Considerable progress has been made and new equipment is being introduced in these areas every day.[3]

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[2]Executive Office of the President, Bureau of the Budget, Automatic Data Processing Glossary, p. 54.

[3]Robert Bosak, "Implications of Computer Programming Research for Management Controls," Management Control Systems, eds. Donald G. Malcom and Alan J. Rowe, (New York: John Wiley and Sons, Inc., 1960), p. 211.

The ultimate goal of effective management information systems is to keep all levels of management completely informed on all developments in the business which affect them.[4] An ideal system would be one which would: First, receive any data, correlate it with information already stored, and store the data; and secondly, have the ability if asked any question, to pull out information and give an answer to the question.[5]

The criteria of management information systems which will provide the required intelligence and information for business management are as follows:

1. It facilitates planning and control, and provides top management with a comprehensive understanding of these factors, both external and internal, which influence the conduct of business.

2. It provides for performance measurement of functional responsibilities, and at the same time, presents top management with the means for overall review of company-wide operational results of a consolidated nature.

3. It provides all information requirements for dynamic operational control in all areas of management structure that are profitable or desirable for the organization as a whole.

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[4]James D. Gallagher, "Management Information Systems and the Computer," The Executive, (December, 1961), p. 8.

[5]Bosak, p. 212.

4. It provides for the development of those informational requirements that are essential to the continued development and application of advanced scientific management techniques.

5. It is dynamic in nature, capable of change to conform with shifts in the socio-economic and political environment in which business must survive.[6]

Another view expressed by computer experts on information systems is the total management system aspect. Mr. R. L. Martino, Manager, Management Systems Department of Olin Mathieson Chemical Corporation stated in a recent article that the functions of a total management system are:

> 1. To predict;
> 2. To compare prediction with actual results;
> 3. To produce the deviations between the predicted and the actual. Thereafter, the system should use these deviations to prepare a new, updated set of predictions which can be used as the basis for management decision.[7]

The predictive function includes the determination and consideration of alternatives, and for each alternative, the effects of decision. The method used in this process is called simulation, a technique wherein the various factors involved in a given

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[6]Norman J. Ream, "The Need for Compact Management Intelligence," Management Control Systems, ed. Donald G. Malcom and Alan J. Rowe, (New York: John Wiley and Sons, Inc., 1960), p. 93.

[7]R. L. Martino, "The Development and Installation of a Total Management System," Data Processing for Management, V (April, 1963), p. 32.

situation are assembled into a model, usually of a mathematical nature. By varying the factors systematically, it is possible to weigh each alternative and its effects.

A total management system produces basically two kinds of information for all levels of management: (1) predictions based on historical data and simulation, and (2) suggested changes of present procedures to make the selected predictions possible.[8]

The predictions are continually compared with actual results to determine deviations. These deviations, in turn, are used to refine or revise the initial set of predictions and strategies. Then, the whole system recycles, producing new predictions.

There is a need in business for total management systems so managers can look ahead and anticipate changes in markets and profit situation. So, a system is required that will forestall the development of an unprofitable business situation. Therefore, the primary objective of total management systems is the production of detailed, up-to-the-minute summaries of the past and use of these summaries to project future activity.[9]

Mr. Richard E. Sprague and other computers experts say that by 1970, nearly all electronic data processing systems will be of an

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[8] Ibid.

[9] Ibid.

on-line--real-time variety.[10] This prediction is based on careful analysis of historical development, present trends, basic economic pressures, and the relationships among all these factors in the fields of management information and control systems, and computer systems.

Just what on-line--real-time management information systems and total management systems can mean to business can be demonstrated by giving examples of existing applications. The first is SABRE, American Airlines' seat-reservation system, which is basically a highly ingenious method of keeping inventory up-to-date on reservation systems. Another example is Westinghouse Electric's steady progress in building up an integrated data system. The aim of this system is to shrink the lead time in the management information cycle to practically zero, and eventually to be able to prepare a final report that will include just about everything top management needs to make its decisions.[11]

There are a number of systems operating in on-line--real-time today. One of the most interesting applications is Lockheed's inexpensive and sophisticated system for controlling costs of what was a complex and intractable production process. This system relieves management of a lot of unnecessary detail. It enables

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[10]Richard E. Sprague, Electronic Business Systems (New York: The Ronald Press Co., 1962), p. 3.

[11]Gilbert Burck, "On-Line in Real-Time," Fortune, LXIX (April, 1964), pp. 143-144.

management to locate work in progress instantly, analyzes costs instantly and maintains complete records of costs and quality of goods purchased.[12]

As in command and control, information is also the power and control behind business cybernetic applications. Only a businessman who knows what is happening inside his company as soon as it happens can truly adjust his means to his aims; and make decisions about these aims. The same is true with the Fleet Commander; he must be able to make "real-time" decisions based on his operations plans and objectives.[13]

The Nonmilitary Decision-Making Process

For an analysis of nonmilitary decision-making before and after the introduction of cybernetics, it is necessary to discuss and define decision-making as it is practiced by the business manager.

Mr. John McDonald in a book by the editors of Fortune states:

> The business executive is by profession a decision-maker. In fact, business executives, along with politicians and military officers, are the principal professional decision makers of the world. Of the three groups, only the military have a formal doctrine.[14]

The question is how do executives go about making decisions? There are many different doctrines and procedures, some

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[12]Ibid., p. 144. [13]Ibid., p. 141.

[14]McDonald, p. 167.

defined, some not so clearly defined. Mr. McDonald in his article discusses this subject at some length. The concensus in his article is that a decision maker in effect stands between past events and future events. He finds a frequency pattern in the past that, projected into the future, gives him a probability of reoccurrence, which is about all the precise, quantitative knowledge he can obtain of the future. But some decisions--for example investment decisions--are novel and nonrepeatable. Most difficult of all are those that are "strategic," i.e., open to upsets by the counter action of competitors. Such decisions are not governed only by laws of probability. Hence, in most cases, the executive has no perfect information, nor has he the calculating capability with which to construct probability expectations in the future. In many situations he faces the unknown. What he does in these situations is not clear.

Peter F. Drucker in his book, The Practice of Management, said decision-making has five distinct phases:

1. Defining the problem.
2. Analyzing the problem.
3. Developing alternate solutions.
4. Deciding upon the best solution.
5. Converting the decision into effective action.[15]

Mr. Drucker divides decisions into two types: First, tactical, which is the unimportant, the routine or problem solving

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[15]Peter F. Drucker, The Practice of Management (New York: Harper and Brothers Publishers, 1954), p. 353.

type. In this case the job is merely to choose between a few obvious alternatives. And the criterion is usually one of economy: The decision shall accomplish the desired end with the minimum of effort and disturbance.

The second type of decisions are called strategic, as mentioned by McDonald. These decisions are important and really matter to the manager. Decisions of this type involve either finding out what the situation is, or changing it, either finding out what the resources are or what they should be. They are called managerial decisions. Anyone who is a manager has to make such decisions, and the higher his level in the hierarchy, the more of them he must make.[16]

Another noted authority on the nonmilitary decision-making process is Herbert A. Simon, who states:

> In order to make a reasonable decision, there has to be an objective or a goal--something we are trying to accomplish. So somewhere along the process it is a good idea to get clear as to what that objective or goal is.[17]

In addition, Simon breaks down the elements of decision-making as follows:

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[16] *Ibid*., pp. 351-352.

[17] Herbert A. Simon, "Background of Decision Making," *Naval War College Review*, (November, 1957), p. 2.

1. Clarifying, stating, or defining the objective.
2. Finding some alternative courses of action.
3. Evaluating the actions in terms of the objective and in terms of side effects.
4. Checking the action out.
5. Acting on the decision.[18]

So, to be sure, there are a number of different doctrines for nonmilitary decision-making. Some are closely related; some are not. The processes of decision-making discussed in previous paragraphs primarily covered practices prior to the introduction of information technology on the business scene. New tools which assist in the process are operations research and tools of information--called information processing and management information systems. Today's manager must understand the basic method involved in making decisions to use these tools. Without such understanding he will either be unable to use the tools at all, or he will overemphasize their contribution and see in them the key to problem solving--not decision-making.

Computers and Decision-Making

After discussing and defining decision-making as practiced in business at this time, it is worthwhile to take a look at computers and decision-making.

Decision-making is an activity which has historically been performed by people. People are defensive about their exclusive

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[18] *Ibid.*, p. 3.

prerogatives to perform and make decisions. To suggest that some inanimate object like a computer will make decisions previously made by people is damaging to the ego and thus constitutes a major form of heresy.

Nevertheless the computer will assist the decision maker and make some decisions. The capability of the digital computer to make a decision has often been described as one of the fundamental characteristics of the set of equipment which constitutes a digital computer system. The concept of automatic decision-making has become inseparable from the computers in minds of most experts today.[19]

The decision-making process when computers are used can be described in terms of data collection, information processing, and decision-making. It is evident from such a description that data reflecting events and objectives are the basis for all decisions made. More specifically, the decision-making process of a data processing system consists of:

1. Data generation for recording of events.
    a. Instrumentation for recording of events.
    b. Written forms for recording of events.
    c. Selecting for proper description of the problem.
2. Information processing.
    a. Solving equations.
    b. Detecting discrepancies from plan.
    c. Summarizing and organizing data.

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[19]John A. Postley, Computers and People (New York, Toronto, London: McGraw-Hill Book Company, Inc., 1963), p. 94.

3. Decision making.
    a. In operating situations.
    b. For planning purposes.[20]

The digital computer can be most active in the information processing phase of this process. Its operation is faster, more comprehensive in scope, and more accurate than any person or group of people can possibly be. The digital computer today is becoming increasingly effective in making decisions based on results of these processing activities. It is of fundamental importance, however, that the value of processing and decision-making based on the results thereof is entirely dependent on the data; no improvement which can be introduced by digital computers in these areas can overcome the inaccuracies or incompleteness of the data. Failure to introduce valid data into the calculations can result only in the more rapid production of worthless results.[21]

Decisions are without question no better than the data on which they are based; they are quite likely to be as good in a system wherein processing and decisions are made by a digital computer, and they are almost sure to lose something in any translation by manual means.

In focusing on decision-making as a critical characteristic of the management job, there is another aspect of recent technological advance that is already leading to changes and may lead to more striking ones in the years ahead. This aspect of

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[20]Ibid., p. 111.

[21]Ibid.

information technology refers to the application of statistical and mathematical methods to decision-making problems. In applying these new techniques the computer is essential.

The new analytical techniques for processing information have developed primarily from the initial impetus during World War II, where the approaches devised then have brought an array of quantitative techniques to bear on a wide range of management problems. Of these analytical techniques, the following are identified below:

> 1. Linear Programming--using a mathematical formulation for obtaining the theoretically best solution for problems of allocating scarce resources among competing uses.
> 2. Dynamic Programming--a mathematical formulation applicable to the problems of economic administration of continuous, interrelated processes.
> 3. Game Theory--introducing into mathematical formulation considerations of strategy and counter-strategy among competitors, to find the best strategy against an opponent's possible actions.
> 4. Statistical Decision Theory--for introducing subjective assessments of probability into mathematical formulations of management problems.
> 5. Heuristic Programming--a computer technique utilizing shortcuts in the form of "rules of thumb" or "heuristics" which greatly reduces the volume of computations involved in solving a complex problem.[22]

The introduction of computers as well as these new tools of analysis are changing the concepts of decision-making and placing more emphasis on the manager as a decision maker. Also questions have been stimulated about the future of management and management

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[22]Melvin Anshen, "Managerial Decisions," Automation and Technological Change, ed. John T. Dunlop (Englewood Cliffs, New Jersey: Prentice-Hall, Inc., 1962), p. 67.

organization. In the next section the implications of this new information technology on management will be discussed to see what the impact is on management today as well as in the future.

The Implications on Nonmilitary Management

The impact of an increasing rate of technological change, i.e., introduction of cybernetics in management information systems, is one of the most critical problems facing management today. It will have more effect on business management and create more problems than any of the other trends in economy and society. First, implications on the upper level of management will be discussed to study the impact of this change in that area.

Implications on Corporation Executives

Management, to keep pace with the new information technology, will have to strive increasingly to become professional, to acquire through training and experience, skills which will enable managers to look at business as a whole, as an integrated system. Freed by management information handling systems from routine tasks, management will learn to focus on broad, long-range policies rather than on narrow, short-term operating or functional problems. The primary concern of executives must be the establishment of a proper policy and framework for the guidance of the organization in relation to its

changing environment.[23]

But once routine decisions have been assigned to the computers, executives will face the unenviable job of having to grapple regularly with a growing number of problems that are too complex for the computers. These corporation leaders will also have to accept the fact that such decisions will become even more complex because of lengthened time span (occasioned by forward planning), changes in scope of decisions (no longer local, regional, or even national, but international), in imposed limits (the increasing role of government), and in resource commitment (needed for larger capital resources).

Management, therefore, must become steadily more analytical and scientific, with the role of "hunch" and even "informed judgment" becoming steadily smaller. At the extreme, this theory will mean increasing use of sophisticated analytical approaches to management decision processes such as mathematical programming and the extensive use of computers. At the very least, the manager will have to be able to isolate and clarify the variables that need to be considered in making decisions, to consider carefully the soundness of the quantitative information gathered about these variables and be able to assign intelligent but frankly subjective weights to variables on the basis of his

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[23]"The Challenge of Technology to Management," Letter by Association of Consulting Management Engineers, 1963, Series No. 1, (October, 1963), p. 1.

experience. This is a process of clarifying and bringing to the surface the variables and implicit logical models now being used by managers and one of improving the logic of the models.[24]

In dealing with new tasks, managers will not only have to employ the tools of information processing and cybernetic management systems, but they will be expected to know, understand, and handle the new concepts and tools of analysis, programming and decision-making, as discussed in the previous section.

Such new concepts and techniques, as awesome as they seem, are going to be welcomed by tomorrow's managers, for their job is going to be so complex, so big, and so demanding as to require all the methods of simplification and systematization that are available.

Because of the intellectual and technical demands that such sophisticated measures place on senior managers, another important change will be employing numerous staff specialists to advise them on special aspects of their work. The top-level manager may have attached to his office a planning staff, a personnel advisor, an economist, a legal counsel, an expert on foreign business, and many others. Similarly, the major production, marketing, finance, and engineering executives will be served by operation analysts, marketing research specialists, statisticians, physicists, chemists, and other staff specialists, in order that increasingly complex

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[24] Ibid.

knowledge from many disciplines can be bought to bear upon strategic decisions of the company.[25]

The Controversial Middle Management Question

According to Harold Leavitt of Carnegie Tech and Thomas Whisler of the University of Chicago, information technology will have four effects on management:

> 1. Planning will be transferred from middle management to top level specialists.
> 2. Large industrial organizations will recentralize with more of the creative functions being taken on at the top levels.
> 3. There will be a radical reorganization of middle management.
> 4. And the line separating the middle management levels will be more sharply drawn.[26]

The effects proposed by Leavitt and Whisler are subject to challenge. The argument used by the experts to refute these effects may be stated as follows:

1. It is erroneous to think that in the foreseeable future computers and analytical techniques will be able to perform even a major share of the complex, nonprogrammable decisions made by managers. But since it is true that computers will in time be able to make most of the programmable decisions, and since many of the decisions made by middle management are of this routine kind, this argument still does not grant a reprieve to the middle

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[25] *Ibid.*, p. 2.

[26] Leavitt and Whisler, pp. 41-42.

manager. But the next two arguments do.

2. It is false to think that, just because a machine can do something better than a man, the machine will be used automatically. To believe that it will is to ignore the economics of the situation. If the computer rents for $12,000 per month, for example, it obviously will have to do more and better work than can 12 middle managers each paid $1,000 per month. Experience to date, however, indicates that computers are pressed to equal efficient human output in areas other than rote arithmetic computation. Once the problems become more complex, difficulties of programming slow down the process considerably, while costs (thanks to machine "down time") soar.

3. Paper gains projected by machine devotees often fail to materialize once a partially computerized decision system is introduced into an organization of human managers. A person would have difficulty knowing this ahead of time. The procomputer literature glows; the technicians within companies see the machines as new fiefs in a growing estate; a few sample runs by the salesman "prove" the machine's superiority over the middle manager. But what happens after installation? Idealized situations often become complicated by individual and group reactions against the machines--motivation suffers and pressures arise. There is, say the followers of this line of thinking, sufficient case evidence available to indicate that until a greater understanding of the problems arising from the interactions of humans and machines is

obtained, the introduction of information processing devices in many companies is going to be slowed.[27]

Time will tell the impact of the new information technology on the middle manager. But it is certain right now a person who desires the title of manager in the future will have to understand the theory, applications and capabilities of the new information and decision-making technologies. The manager who does not understand this role will inevitably become subservient to the superior knowledge of professional experts in the new business science. Obviously, then, the managers of today will have to grow with the challenge, through education--formal or otherwise.

The Decision-Making Process

The decision-making process after the introduction of cybernetics was discussed at some length earlier in this study. Some top managers and computer experts in nonmilitary enterprises believe that the major effect of information processing and related management information systems techniques on management functions is to facilitate the decision-making process. This effect will be accomplished by giving the manager accurate and timely information with which to measure more precisely the

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[27]"The Challenge of Technology to Management," Letter by Association of Consulting Management Engineers, 1963, Series No. 1, (October, 1963), pp. 2-3.

economic and operational consequences of a decision. The decision cannot be an automatic response to the information input. The manager's judgment, and the responsibility for the consequences, will not be transferred to a data processing system, at least not in the foreseeable future--and never in the area of top management decision-making.[28]

Other experts point out that decision-making is in a transition from traditional to modern techniques. Instead of judgment-intuitive type decision-making, the major decisions will be made through operational research and other techniques. As discussed earlier, this method of obtaining solutions is placed in terms of mathematical and statistical studies of relations between variables to provide the best alternative among a number of alternatives. Information processing will handle and manipulate the data necessary for decision-making.

There is no question, in the decision-making area, the information technology impact on management is in progress. The use of such theories as heuristic problem solving, game theory and linear programming indicate that a transition in decision-making is taking place in the business world today.[29]

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[28] James D. Gallagher, "Management Information Systems and the Computer," The Executive, (December, 1961), p. 9.

[29] Walter Buckingham, Automation: Its Impact on Business and People (New York: Mentor Executive Books, 1963), p. 53.

Essentially, improvements in management decision-making will arise because of three basic processes:

1. The quantification of selected data will substantially improve not only the amount of facts in a specific report bearing on a specific decision area; it will also improve the information content.

2. Decision-making will also be based on the evaluation of a wider range of alternatives and of current factual data, rather than on intuition and the extrapolation of historical data.

3. The impact of decision in one functional area on other functional elements of a business will be more easily measured and, as a result, a more comprehensive view of the business can be taken.[30]

Centralization or Decentralization?

The question of centralization or decentralization has been a controversial one for a number of years. Henry H. Albers in his book Organized Executive Action stated that "the emphasis in recent years has been to the philosophy of decentralization but the student of management should not neglect the importance of centralization."[31]

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[30]Gallagher, p. 11.

[31]Henry H. Albers, Organized Executive Action (New York: John Wiley and Sons, Inc., 1962), p. 156.

Another expert, Walter Buckingham, said: "Information technology allows management to cope with increasingly complex problems using fewer people and a more centralized organization."[32]

The concensus of most, in the literature on the question of centralization or decentralization, is that the introduction of cybernetics has slowed the progress toward decentralization in nonmilitary organizations and movement now is toward recentralization. Companies adding new units that previously would have been granted considerable autonomy will now depend on a strong central control, not only in operational planning but in setting of operating and financial policy.[33]

Although the trend is toward recentralization, there are still a number of questions which need answering. Such as: Is there a tendency toward geographic centralization or decentralization? Is there a tendency toward greater administrative centralization or decentralization?

The Planning Process

The rapidity of technological change is forcing companies to pay much more attention to the planning process, especially

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[32]Buckingham, p. 54.

[33]Auren Uris, "What's Ahead for Middle Management?" The Executive, (October, 1963), p. 21.

planning for change, and its counterpart, planning necessitated by change.[34] A few reasons this is happening are:

Product life is being shortened. The traditional cycle of product innovation is being telescoped--not by planned obsolescence or styling changes, but by genuine technological innovation. The scientific revolution, such as the break-throughs in electronics, physics, chemistry and mathematics, have made possible a surging flood of new products, new materials, new processes and new techniques. The potential they create for greater change is enormous.

The reaction time of management must be reduced. Leeway in adopting to scientific change has disappeared. Management must keep track of a number of fundamental areas of scientific work, and must be skilled in identifying and exploiting emerging opportunities ahead of competition. Management must continually interpret the total marketing climate in terms of rapid technological change.

The life of business and industrial processes, as well as products, is being both shortened and changed. Much of the new technology, particularly that part dealing with information processing, is beginning to affect the manner in which business is conducted.[35]

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[34]"The Challenge of Technology to Management," Letter by Association of Consulting Management Engineers, 1963, Series No. 1, (October, 1963), p. 3.

[35]Ibid.

The increased complexity and tightened interrelationships of functions within a single organization, together with the ever more complex relationships with other organizations mean that successful and rapid adjustment to change is impossible without the ability to plan effectively.

For these reasons, and many more, management must sharpen its ability to anticipate the future more precisely in its overall planning responsibilities.

It is clear that a gradual evolution is taking place in the business and industrial processes, organization structures and the process of managing under the impact of technological progress. This change threatens the survival of established companies with myopic managers, just as it creates opportunities for those managers who fully grasp the nature of the environmental changes that information technology is producing.[36]

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[36] *Ibid.*

CHAPTER V

THE IMPLICATIONS OF CYBERNETIC COMMAND AND CONTROL SYSTEMS ON THE FLEET COMMANDER AND HIS STAFF

The Changing Role of the Fleet Commander and His Staff

Before discussing specific implications, it is worthwhile to place the Fleet Commander in the role of a commander and manager of an on-line--real-time Cybernetic Command and Control System. The role as presented here is not completely operational in the fleet, but based on the movement of both, the technological revolution and information technology; systems of this type will be installed and used by commanders in the near future.

The introduction of cybernetics, the rapid advances of weapon systems, and time periods to react have presented the Fleet Commander with a real challenge. As Captain Mason Freeman, U. S. Navy command and control head stated in a recent Armed Forces Management magazine:

> If nuclear war should come, we'll have time, because of surveillance capability, to make the original commitment of forces from the National Command and Control Center. From there on, the Commanders will be largely on their own and we will provide them with the necessary tools to the best of our ability.[1]

Time periods for Fleet Commanders to react have changed. Twenty years ago, during World War II, time was measured in days and hours for command decisions. Now, time has been reduced to seconds--"real-time." The power of weapons when combined with reaction time implies an important challenge to the Fleet Commander of today. This is especially true when he receives the "go ahead" from the National Command and Control Level. Under these conditions the implications are that the Commander's decisions in a short time could level countries and have far-reaching effects on a world-wide basis.

The Fleet Commander's information needs are affected by the forces environment; i.e., type of conflict (cold war, limited war, general war); conflict phase (tension, potential warning, exchange, recovery); physical location (in-port, underway); doctrine (scope of command); and support conditions (communications, intelligence, logistics).[2] So the Fleet Commander's information

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[1] "The Naval Tactical Data System: We Have More Than 800 Command and Control Systems," Armed Forces Management, (July, 1963), pp. 44-45.

[2] "Where the Computer Fits in Command and Control," Armed Forces Management, (July, 1962), p. 24.

needs will depend on the specific conditions under which particular operations are being conducted. Large volumes of data may be needed, or under another set of conditions requirements could be critical items in the shortest possible time.

The complexity of warfare has increased for the Fleet Commander; the number of parameters, and the many courses of action which will be available to the Commander will be solved by a Navy Cybernetic Command and Control System.

Command and Control Systems are the means by which the Fleet Commander controls his ships, weapon systems, obtains knowledge of enemies' capabilities, and takes into proper consideration factors bearing upon these forces.[3] The major elements of his command and control system can be classified as "structural" and "technical."[4] The structural part of the system is the Commander's staff, the organization imposed on the staff and the procedures and doctrines the staff follows. Technical elements of the system are the communication system, computers, sensing equipment, other technical aids and specialists who operate these parts of the system. The structural element of the command and control system is the job of a military strategist or tactician, such as the Fleet Commander.

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[3]Fred W. Kittler, Captain, USN, "Command Control--The Navy's Link to Global Strategy," Naval Engineers Journal, (February, 1963), p. 31.

[4]"The Search for Effective Command and Control," Armed Forces Management, (July, 1962), p. 19.

The Commander's staff must be able to perform a multitude of tasks in providing timely information to aid in command decisions. The information system must be capable of receiving, by all possible means of transmission, updated information of many kinds. The information received must be analyzed by the staff and added to the file of existing information. If calculations have been based upon previous information, new processes of calculation or extrapolation must be initiated. Finally, the Commander must be able to extract meaning from all this information.

One important factor of command and control is the isolation of the decision maker; the Fleet Commander must be separated from the massive and complex data manipulation functions. It is essential that the maximum amount of information necessary be provided for the Commander's task, but at the same time the minimum amount possible to cut down the digestive, interpretive, and possible confusion aspects of the output information.

The role of the Fleet Commander can be broken down into two areas: the role of a Naval Commander as a planner and executor of strategy and tactics; second, the role of a manager in the management control of the Cybernetic Command and Control System. These factors have made a different type Fleet Commander than that pictured ten years ago. The Commander of today must be redesigned into a highly trained specialist who will have an ingrained operational knowledge of tactical force operations combined with a

thorough understanding of the management concept of automation.[5] These characteristics are essential to the use of command and control systems in the maneuvering of modern warships.

The introduction of automation into command and control systems has not decreased fleet operations' dependence on the Commander and his staff. The computer has removed much of the menial-numbers and paper workload and has provided the Commander and his staff with needed time for studying and making decisions on the conduct of force operations.

The Fleet Commander's Requirements in Cybernetic Command and Control

The new approach to command and control must be the "total systems" approach due to "real-time" requirements on the Commander and his forces. This system must be complete force control by computer analysis; such as an integrated automated system for each ship, as well as the entire force; each ship and the force will have the capability of automatic steering which can be controlled by the Fleet Commander or by the individual ship's Commanding Officer; an automatic navigation system with automatic collision avoidance equipment installed to steer on a preselected (programmed) course and avoid collisions automatically when moving

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[5]Fred W. Kittler, Captain, USN, "Command Control--The Navy's Link to Global Strategy," Naval Engineers Journal, (February, 1963), p. 31.

from one area to another.[6]

A considerable number of attack options must be provided to meet a large set of predicted military situations. Therefore, the computer must be a general purpose, digital type with "real-time" operation capability and wide ranging and flexible information request devices. The system must be capable of accepting revision, restraints and parameters by the Fleet Commander so a workable operation order can be derived to conduct operations. The Commander must be able to collect information and immediately process and compare it with the basic information he carries aboard in his system. Simultaneously, the system must speed the results of the collection to higher command.

Date Processing Systems

To further illustrate requirements of Cybernetic Command and Control for the Fleet Commander, it is necessary to look at the Data Processing System concept which includes three of the elements listed above.

The Data Processing System is a major area of concern for the Commander because information is assimilated, stored, correlated and extrapolated to provide the Commander with decision-making information.

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[6]Robert E. Stark, Captain, USN, "The Ship as an Integrated System," Naval Engineers Journal, (May, 1963), p. 328.

The primary Data Processing System, in support of the Fleet Commander's decision-making, consists of three central parts: input, data processing, and output. The system can best be illustrated by the following diagram showing the data system's functions.[7]

INPUT EXTERNAL (SENSORS) INTERNAL (FORMATS)	DATA PROCESSING	OUTPUT

CAPABILITIES

Electronic	Mass Data Storage	Group Display
Automatic	Data Processing	Console Display
Semi-automatic	In/Out Communication	Hard Copy

FUNCTIONS

Management	Data Base	Management
Formatting	Maintenance Analysis	Searching
Monitoring	Information Retrieval	Editing
Logging	System Management	Formatting
Screening		Monitoring

Figure 2.--Data Processing System's Functions

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[7]Walter F. Bauer, "Military Command: A Challenge for Information Processing," Computers and Automation, (April, 1963), p. 9.

This figure summarizes the capabilities and functions of the three central parts of the system. The input area deals with receiving of data from external sources as well as data prepared internally. The main function to be performed by the input system is the entire management of input data.

An output system must provide communications to humans through group display, console or individual display, and hard copy print-outs. The functions are entirely similar to those of input. In addition to the functions of formatting, logging, and editing, there is an additional function of information retrieval or file searching. The output system may have an input capability all its own. It may have, for example, a man/machine console to make information requests and to generally direct the information to be put on the group displays.

Data processing capabilities are as shown: data processing and communications with input and output. The functions are to maintain the data base, to analyze data, and to retrieve information. The last item, that of total system's management, is important because it refers to the overall electronic management of the automated system.

The primary computer system is the central computer system, which is the technical heart of well-integrated command and control systems. It stores information such as contingency operation orders, assimilates and correlates revisions of orders, and manipulates all information received to provide the Commander

with necessary information for decisions and issuance of orders.

Man/Machine Concept

Another most important concept of command and control systems is the close relationship needed between the Commander and the equipment--"man/machine" concept. The machine system must be organized to give and receive data from the Commander on the Commander's terms.

Figure 3 portrays the close relationship between man and machine in a cybernetic command and control environment.[8]

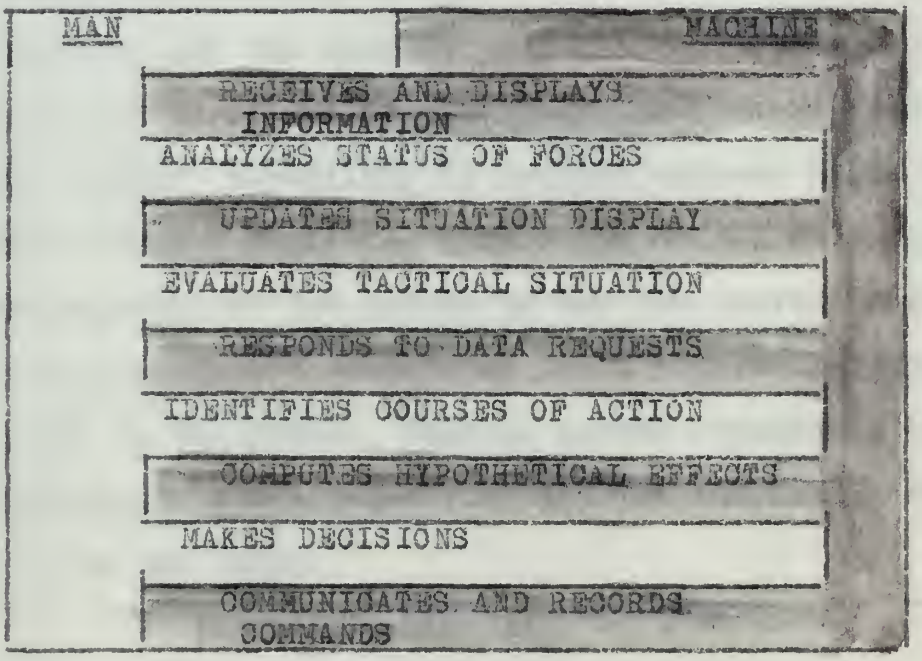

Figure 3.--Man/Machine Coordination

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[8] Bauer, p. 10.

Prior to attack, as well as during attack, the machine receives information from communication devices and secondary-supporting computers and displays the information. The Commander, the man, analyzes incoming information as to the status of his forces and those of the enemy. This machine receives additional information and updates the situation display. The man evaluates an operational situation based on information the machine has displayed. In so doing requests are made of the machine to which the machine responds, since it is impossible for the system to cover, under normal output procedure, data reflecting all contingencies in which the Commander might be interested. The man identifies certain courses of action and the machine computes hypothetical effects based on various possible choices. The man makes the decision and the machine communicates commands to the other ships in the force and at the same time records them. The "hypothetical effect" capability in command systems helps the Commander make correct decisions during the actual attack.[9]

Interrogation of the system by man can provide the Fleet Commander with important information; i.e., request for weapon status of ships in the force. Through proper formatting and compatible language, the machine will provide the weapon status for each ship in the force.

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[9] _Ibid._, p. 11

The Data Processing Systems and sub-systems organize information into a more readily usable form to help the Commander better plan to make faster and more knowledgeable decisions.[10] So it is important to realize that a Fleet Commander's prerogative is not in any sense usurped by the processing system. The electronic system extends his intellect and amplifies his ability to handle many facts affecting decisions. Therefore, a human element in the command and control process is necessary and very important today as well as in the future.

Fleet Commander's Viewpoint

The Commander's viewpoint of the system is presented to illustrate how information is obtained for decision-making purposes. Therefore, the Commander's viewpoint is presented in the following chart.[11]

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[10] Austin M. Porter, "Command and Control," Naval Engineers Journal, (February, 1963), p. 27.

[11] Bauer, p. 12.

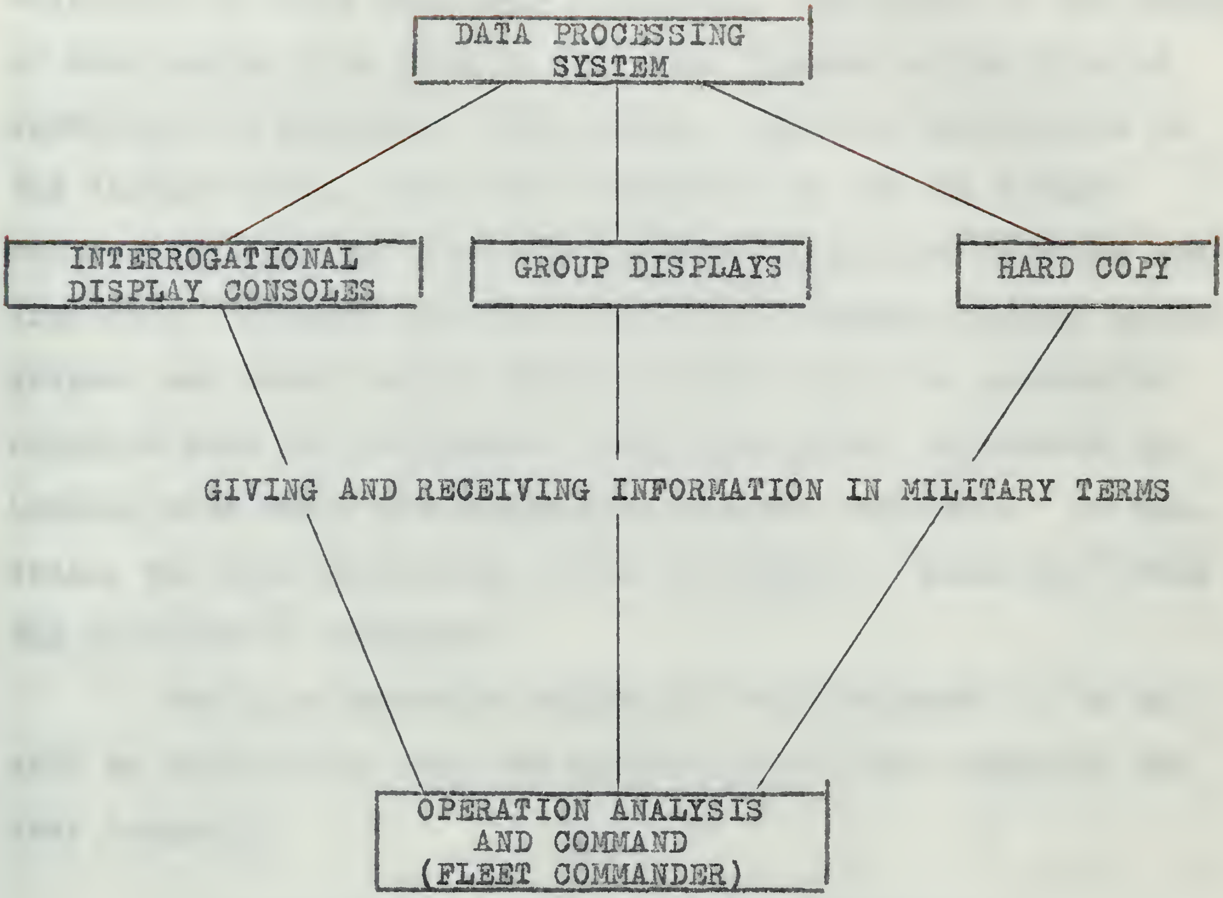

Figure 4.--Fleet Commander's Viewpoint of the Data Processing System.

As shown in Figure 4, the Commander will receive information from the machine, from console displays and group displays, and from hard copy printouts. The ratio of the amount of data coming from each of the areas depends on the type of operations in progress. The primary source of information is the display areas, where the Commander can see the entire tactical picture and make the necessary decisions from the data displayed. Console displays reflect the working display to help prepare and format group displays and to react to particular requests from the Commander. Hard copy output represents the back-up data which are frequently used for reference. At this stage, the data processing system is simply a "black box" from the Commander's viewpoint.

The most important aspect for the Commander is to be able to communicate with the machine in his own language; the Navy language.

Specific Implications on Fleet Commander and His Staff

Implications of new technology and cybernetics on the Fleet Commander and his staff were partially covered in the first section of this chapter, the changing role of the Fleet Commander and his staff. To further analyze these implications, specific areas of impact will be discussed to provide insight into the changes and effects of cybernation in fleet command and control environment.

Centralization Trend in the Navy

In the past policy-making civilians and top level commanders at the national level devoted their attention to general strategic direction, leaving details of operations to the lower echelons, i.e., Fleet Commander. Today, not only the basic decisions on the Navy's participation in any conflict and the response to any threat, but decisions relating to use of weapons which might cause the escalation of a small war into a large one will be made by the top officials in Washington beginning with the President.[12]

The trend is toward an increasing volume of information exchange throughout the chain of command, from top to bottom and bottom to top. The Fleet Commander will be required to furnish, through the National Command and Control System, more information than ever before and at a much more rapid pace. The result is that Cybernetic Command and Control Systems will be required to acquire, screen, collate and display information in transmitting reports, decisions and orders throughout the chain of command.

National political leaders have made it clear that the use of military forces world-wide must be centrally monitored and controlled in Washington. These top leaders have observed

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[12] Porter, p. 28.

that the implications of all actions, political and military, are interrelated, without respect to geographical or command boundaries. It has also been concluded that uncontrolled action at any point can trigger reactions escalating to nuclear war; therefore, the risks implicit in initially decentralized control cannot and will not be taken, especially at the beginning of any conflict.[13]

Means must exist for two kinds of control which are opposites in theory but complementary in fact. Centralized control must be available from the highest level to the smallest military unit if that unit is the military force to be applied at a precise location, and if the decision to use it must be quickly made at the national level. Decentralized control must also exist at all levels of command. If the means for decentralized control do not coexist, the entire structure could collapse if the center of control were to be destroyed or rendered impotent through loss of its ability to communicate. A military posture dependent solely on centralized control without the alternative decentralized system and procedures for its uses is a delusion and would create major problems in this technological age.[14]

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[13] Ibid.

[14] Ibid., p. 29.

From the Fleet Commander and his staff's viewpoint, this centralization trend removes some of the Commander's decision-making to a higher level in the chain of command. In case of limited war major decisions would be made at the national level; on the other hand, if needed, the Fleet Commanders and other lower level commanders must have at their finger tips the ability to step in to take command of the situation.[15]

Effects on Fleet Commander's Staff and Intercommand Relations

The introduction of cybernetics into command and control systems will not significantly decrease dependence on the Commander and his staff for informations processing. Further, the computer system will be embedded in the operation, language and mission of the Fleet Commander. The computer will remove much of the menial-numbers workload--providing the Commander and his staff with much needed time for studying the situation and making decisions.[16]

In the analysis of the Fleet Commander's staff, the functions of the staff were discussed to provide a framework for

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[15] "The Naval Tactical Data System--We Have More Than 800 Command and Control Systems," p. 44.

[16] "Where the Computer Fits in Command and Control," Armed Forces Management, VII, (July, 1962), p. 22.

studying the implications on the role of the staff in the performance of these functions.

In regard to the task of providing information, computers will be able to collect, assimilate and manipulate data for the staff's use in all areas of the command process. These functional areas include administration, intelligence, operations and plans, and logistics. The menial-numbers and slow process of collection will be replaced by the rapid and more accurate work done by the computer. The Commander will have more information as well as more alternatives when he is making a decision on the conduct of his forces.[17]

In anticipatory planning and recommendation for plans and orders, cybernetics will assist the staff in preparation of contingency operations plans which can be placed on the computer to be used by the Commander as combat events occur. These plans would be stored in the computer in the form of an information base. This information base, required for automating command operations, is the primary concern and the direct task of the Fleet Commander's staff. The staff must also maintain the information base, develop plans, lay out programs, establish planning factors and specify operating procedures. Thus it is from this daily work of the staff, from the dynamic perspective

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[17] *Ibid.*, p. 23.

of the command context, that the informational requirement of staff headquarters must be generated. The staff will establish an information base as a result of real and present needs for information, plans and programs required by the Fleet Commander.[18]

Workload of the staff will be reduced in the area of written directives and orders. The command and control system will be able to carry the bulk of communications formerly handled by other means. This staff will be responsible for translating and being sure these orders and decisions are relayed to subordinate commanders, as well as seniors in the chain of command.

Supervising and evaluation, another function of the Commander's staff, can partially be handled by computers through the feedback principle which would let the staff know if directives are not being acted upon. The supervising and evaluating tasks will be performed more rapidly and with more precision than ever before. In evaluating plans and orders, results will be brought into the open, and the staff will be able to program future planning easier and with more confidence.

A Fleet Commander's staff, like his force, develops a personality shaped by its sense of common purpose and is greatly influenced by the personality of the Commander. It is this cohesiveness, this team spirit, that enables the Commander to adapt

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[18] Nicholson, p. 79.

quickly to changing situations and to insure a continuity of dedication throughout his forces. The advance of cybernetics in the Navy environment has had its effect on warfare. The probability is that in future war very few men will actually see their enemy; they may not even have a mental picture of the targets at which they will fire; and associated friendly units may be mere points on a map or blobs of light on a piece of equipment. But even when this proposition is so, our concept of command and staff organization in the sense of team spirit, will not be changed. An introduction of automation and computers into the command process may make this concept more difficult to maintain, but nevertheless it will still be there.[19]

Several things happen when computers are introduced into the Fleet Commander's environment. For example, it is hard to argue with a computer. The computer responds quickly with a precise and very definite answer to a question or it gives no answer at all. No computer ever said in response to a question, "I never thought of that. Let me think about it." Also, it is hard to compete with a computer on its terms. If a computer is programmed to evaluate alternative courses of action, given certain facts, it will do just that and no more. It will do it so fast and in such detail that even if a bright young staff officer thought of a new way in which the facts might be construed he would

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[19]Chastain, pp. 44-45.

hesitate to say so. Finally, the computer executes only preplanned operation; it never volunteers. Such factors as these may exert an influence over the staff and the Commander, as well as the decision-making process. A person seldom questions the results of a computer, but the staff should be positive too that the results obtained are the best possible for the Commander's purpose.[20]

Implications on the Decision-Making Process

The concept of the military decision-making process, as discussed earlier in this study, will not be changed from the "estimate of situation" doctrine. But information processing and the introduction of cybernetics into command and control have opened up entirely new possibilities in the Fleet Commander's decision-making capabilities. By eliminating redundant information, by comparing and screening data, by sorting and programming significant bits of intelligence, it is possible to reduce an overwhelming amount of facts to manageable proportions which a Commander can comprehend and upon which he can base sound decisions. Because of the broad scope of the data base which information processing makes possible, the Commander can make decisions which will have a greater degree of validity than ever

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[20] *Ibid.*, p. 45.

before in history. Speed is attained, not necessarily by swifter decisions, but by practically instantaneous assimilation of vast amounts of data by means of information processing systems.[21]

Man is still the most effective decision maker. The problem is in his present ability to be aware of all the factors, or data, in sufficient time, quantity and quality, that bear on a given situation.[22] Cybernetics and systems such as the Naval Tactical Data System are in the progress of solving this problem for the Fleet Commander.

Admiral Robert B. Carney, U. S. Navy, pointed out in a speech at the Naval War College, Washington, D. C. that the new technology must be used by the Commander in making decisions:

> With the widening range of effectiveness of weapons and electronic technology, the tactical commander must rely increasingly on electronic collection of information, data processing, and selection of courses of action. Furthermore, many of the important functions inherent in arriving at command decision, must be decentralized to subordinates because of complexity and time factors. The commander will be plagued by doubts and worries unless he is keenly informed concerning the workings, capabilities, and the limitations of the systems which now serve him in collecting and processing information and indicating his best course of action. The commander cannot be absolved from his overall responsibility, but a considerable measure of his volition has been infringed by the realities of technology.[23]

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[21] McQueen, p. 27.

[22] E. W. Seabrook Hull, "To Free Man for Combat," Data, (December, 1963), p. 35.

[23] Robert B. Carney, Admiral, USN, "The Gray Areas of Command and Decision," Naval War College Review (September, 1961), p. 4.

It should be noted that the command and control systems being considered in this report do not propose to turn over to computers the making of important decisions. Rather, the systems must be viewed as man/machine complexes in which the machines do much of the routine work but men are incorporated in the system at any point where human judgment is required. Deciding where these points are, however, is no easy task. Perhaps the easiest "rule of thumb" to use is that when either a person or computer could perform a given function, but the person could perform this function only by following a set of rules as precise and explicit as an algebraic formula, then the computer should perform the task.[24]

The Cybernetic Command and Control Systems as discussed in this report provide the key to effective decision-making, to safe and accurate weapon response to decisions, and to the desired force manipulation.

Military Decision and Game Theory

The United States military doctrine of decision prescribes that a commander select the course of action which offers the greatest promise of success in view of the enemy's capabilities of opposing him. O. G. Haywood, Jr. has developed an analogy

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[24]Chastain, p. 42.

between existing military doctrine and the "theory of games" proposed by Von Newman. The techniques of game theory permit an analysis of the risk involved if the Commander deviates from current doctrine to base his decision on his estimate of what he intends to do rather than on what his enemy is capable of doing. The idea of "mixed strategies" presents more difficulties but may be useful, particularly for command decisions for small military organizations.[25]

In large organizations, possibly through game theory or some other operations research technique, a staff may be able to base its planning on both enemy capabilities and intentions, providing the Commander with additional information and more alternate choices in reaching a decision.

One of the characteristics of the computer and cybernetics that make it unique among technical achievements is that it has forced men to think about what they are doing with clarity and precision. A man cannot instruct the computer to perform usefully until a plan of attack has been developed. Even scientists, having wrestled with a computer's demands on knowledge and logic, are astonished to discover how mental activity travels in ruts. The rethinking process becomes more difficult as the computer gets better.[26]

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[25]Haywood, pp. 365-366.

[26]Burck, (March, 1964), p. 101.

Professional Excellence of Fleet Commander and Staff

The technological revolution requires of the professional military officer more intelligence, more education and more expertise than he has ever had before.[27] Vice Admiral W. R. Smedberg made these facts very clear when he said:

> There is no doubt that the average officer of the future Navy will need more scientific education than his counterpart in today's Navy. . . . Similarly, commanding officers will require a basic knowledge of all the systems of their ships--even those of increasing complexity, in order to employ these systems effectively.[28]

Professional excellence is mandatory for the Fleet Commander and his staff since the advent of cybernetics. They too must be experts in their job.

The Fleet Commander and his staff must have a thorough technical knowledge of command and control, and of weapon systems under their control. The absence of such knowledge may mean defeat instead of victory. The leaders who emerged victorious from conflicts in the past were experts in their profession.

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[27] Samuel P. Huntington, "Power, Expertise and the Military Profession," The Professions-Daedalus, (Fall, 1963), p. 785.

[28] William R. Smedberg, III, Vice Admiral, USN, "Manning the Future Fleets," U. S. Naval Institute Proceedings, (January, 1963), p. 122.

But today, as never before, professional excellence is demanded of the Fleet Commander and his staff. Due to the complexities of politico-military decisions, the nature of command and control, new weapon systems and strides made in information processing, the requirement for knowledge has multiplied to a sizable degree, covering such things as nuclear physics and propulsion, new concepts in decision-making and cybernetic command and control.[29]

Intelligence and communications are mere aids to combat, but very essential to the Commander. Only when they are merged with a thorough technical comprehension on the part of the Commander may these aids bring about an accurate decision in an atmosphere of time-compression. It is clearly understood that information about the enemy is important, but only the proper utilization of those data by a highly trained commander will determine the critical issues of the modern military engagement.[30]

A substantial amount of training is being conducted to handle command and control systems. Mr. Paul Conklin of the Armed Forces Management magazine, pointed this out in a recent article when he said

> Programmers, operators and other personnel are being trained to handle NTDS and other types of command and control systems. Additional and more training is needed in the top level officer categories to develop improved software and to manage these new systems.[31]

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[29]John T. Hayward and Paul J. Keaney, "Command and Control in the Nuclear Age," U. S. Naval Institute Proceedings, (November, 1963), p. 43.

[30]*Ibid*.

[31]Conlin, p. 30.

Although a substantial amount of training is being conducted, there is a need for more and better personnel who know both cybernetics and command and control. Most highly trained specialists in computers do not understand naval operations--or professional top-level naval officers do not have sufficient training to manage and control Cybernetic Command and Control Systems.[32]

Philosophy of Command

Earlier in this study the nature of the command process, the organization of the Fleet Commander's staff and its responsibilities were discussed to provide a guide for further study into the subject area. The Navy's concept of authority and responsibility and its application in the case of the Fleet Commander was outlined to lay a basis for investigation and analysis. In reviewing the functions of the Fleet Commander, after the introduction of cybernetics into his environment, there is no question that command is still the governing principle today as it was in the past. Although the increase in size of forces, expansion of the field of combat and centralization of control aspect have created problems as well as implications for the Fleet Commander, the ultimate command responsibility has remained undiluted by the lengthening chain of command.

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[32]Chastain, p. 46.

The growth and present form of the Fleet Commander's staff derive directly from the increasing burden on the Commander. Unable to divide his command responsibility, the Commander has assistants to acquire, assemble, and evaluate the increasing number and variety of facts, figures, and reports needed to make adequate plans and to reach correct decisions. Once orders based on these decisions are issued, the staff provides the necessary extension of the commander's power to monitor and control the execution of the orders and directives issued.[33]

Cybernetic Command and Control Systems provide the means for the staff to handle the Commander's burdens faster and better than they could during World War II. Since the war days of staff work, the Fleet Commander's staff has increased in size and has come to incorporate the wide range of technical specialists on the staff today.[34]

With computers assisting the staff in performance of their functions, more specialists have been required, such as programmers, systems people and others highly trained personnel. In the future as the integrated system becomes operational, sub-system areas will be automated. Even more technical people will

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[33]Chastain, p. 34.

[34]*Ibid*.

be required for staff work. Looking into the future, the size of the staff will be reduced, but the number of specialists will be increased.

The details of execution, although influenced by established doctrine and operating procedures, are the business of the Fleet Commander and his subordinate commanders. The Fleet Commander's purpose is the control of detailed action in progress. So far, the adoption of new and better communication and control devices has been done with an awareness that if the principle of command responsibility is to be retained, the value of tactical initiative maintained, the flexibility and power in weapons sustained, the nation must adhere to the tested principle of centralized command with decentralized combat control at the scene of action.[35]

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[35]*Ibid.*, p. 37.

CHAPTER VI

AN ANALOGY OF MILITARY AND NON-MILITARY IMPLICATIONS

It is the consensus among computer professionals that most scientific and business systems, especially large-scale ones, will become on-line and will have important man/machine aspects.[1] Therefore, these military systems, i.e., Navy command and control systems, represent pioneering technical efforts in information processing systems; they are the vanguard of a new and important generation of information processing systems. Future scientific systems will look functionally like command and control system functions.

These new systems will receive data from many tasks simultaneously. Functions of input and output will grow in relative importance and complexity to central processing; multi-computers will be called upon to implement the tasks.[2] Consider the multi-operations of a future scientific system in a typical aero-space company: Test data are continuously arriving from

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[1]Bauer, p. 13.

[2]*Ibid.*, p. 14.

outlying stations and being formatted. A trajectory problem is being run, man/machine requests are being updated on reliability and inventory records. Up-to-date information is forwarded to the company and handled in "real-time."

Both the Commander and the executive require information by automatic techniques for decision-making.[3] As an example: A marketing executive--this executive must receive information from many sources such as advertising agencies, sales outlets, and supply or inventory areas; then decisions are made involving prices, shipments, and further advertising. The Commander receives information, also from many sources, including intelligence, communications and operations; then decisions are made involving weapon systems, tactical maneuvering and other operational decision-making.

An area where business and military management can be compared is centralized and decentralized control, and decision-making. The trend is toward an increasing volume of exchange throughout the chain of command in the military organization, as well as through the levels of the business organization. One of the reasons for this increased flow of information is automatic data processing. This means there is an increasing need for acquiring, screening, collating, displaying and evaluating information, and in transmitting reports, decisions and orders.

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[3] *Ibid.*

In both business and military, control must exist at all levels. When Automatic Data Processing for control is used in military, such as in command and control, centralized control must be available from the highest level to the smallest military unit if that unit is the military force to be applied at a precise location and if the decision to use it must be quickly made from the national level.[4]

Decentralized control must also exist at all levels. This is necessary since any level of command could be destroyed or rendered impotent through loss of ability to communicate. These two theories--centralization and decentralization--are opposites in theory but complementary in fact.[5]

Business in recent years has placed emphasis on the philosophy of decentralization. But the consensus is that centralization cannot be neglected, especially when companies use automatic data processing. Decentralization without centralization means organizations cannot survive--companies require coordination and a unity of purpose.[6]

For further comparison of military and nonmilitary, a look at the effects of changing technology on management is worthwhile.

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[4]Fred W. Kittler, Captain, USN, "Command Control--The Navy's Link to Global Strategy," Naval Engineers Journal, (February, 1963), p. 32.

[5]*Ibid.*, p. 28.

[6]Philipson (ed.), p. 71.

The business manager of the future will have to recognize that many accepted business concepts have become outmoded as a result of rapid shifts in technology. The military commander is required to look at planning from an entirely different view, due to the need for the right information at the right time. The business manager, as well, will have to look at business planning from a different viewpoint. For example, due to automation, management will have a capacity never before possible to centralize or decentralize its decision function. The same is true in the military. Even as fundamental a concept as the definition of a business may have to be changed just as the Fleet Commander's concept of combat is being changed due to command and control.

Planning is an important aspect of command and control management, as it is in business management. The Commander requires concrete planning to cover any foreseeable contingency in operations. The manager in business must also plan. He must plan for change; and its counterpart, planning necessitated by change.[7] The reason the manager must pay closer attention to his planning is that by competition through technological innovation and scientific revolution the commercial life of a company's product is shortened. It has shortened the life of business and

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[7]"The Challenge of Technology to Management," Letter by Association of Consulting Management Engineers, 1963, Series No. 1 (October, 1963), p. 4.

industrial processes, but has increased the complexity and tightened the interrelationships of functions.

Next, an analogy can be made between military and non-military implications in the area of decision-making. As the pace of warfare has quickened, there has been a shift of emphasis from the tactical decision (moment-by-moment direction of battle) to strategic planning (preparing for possible eventualities, establishing policy, and determining in advance how tactical decisions will be made.) The Navy Fleet Commander can no longer plot the course of enemy's ships on a chart and personally calculate the aiming point. In fact, with a ballistic missile there isn't sufficient time to select a defensive weapon.[8]

Equally in business: As the pace of technological change quickens, corporate management, even at the lower levels, must focus more and more on the strategic problems of running the business and less on the everyday operating problems.[9]

As the complexity of war has increased due to the technological change, the duties of naval command have multiplied until the Fleet Commander of today is immersed in executive and administrative tasks that resemble those of a corporation

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[8] Jay W. Forrester, "Industrial Dynamics: A Major Break Through for Decision Makers," Harvard Business Review, (July-August, 1958), p. 39.

[9] Ibid.

president. The major difference which sets the Commander apart is the undiminished operation of the principle of command responsibility.[10] The Commander has truly become a planner and decision maker in the corporate image, while retaining the military leader's moral, legal and historical responsibility for implementing those plans and decisions.

Just as the Commander resembles a modern corporate executive, his staff also resembles the management echelon of a large and diversified firm. Of course there are differences, such as the principal characteristic of the military staff, its identification with and relationship to the Commander. The philosophy, indeed the personality, of the Commander pervades his staff in a way and to a degree entirely unlike the workings of corporate policy. This group of diversified specialists, whose collective technical ability is an absolute prerequisite to command of a large force, become a cohesive and finely tuned instrument to extend the span of control of the Commander.[11] It is this atunement, this linked intelligence, that permits decision-making by the Commander across a range of technical matters that would be completely beyond the capability of any one man to master. And it is by the same unique linkage of intelligence devoted to a common

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[10] Chastain, p. 34.

[11] _Ibid._, p. 35.

purpose that the far-flung and diverse elements of command are welded into a force capable of coordinated action. The trend in industry is the same. The corporate president, because of intellectual and technical demands, must have a staff of specialists to advise him on special aspects of his job so all the possible knowledge can be brought to bear on the problem in question.[12]

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[12]"The Challenge of Technology to Management," Letter by Association of Consulting Management Engineers, 1963, Series No. 1 (October, 1963), p. 2.

CHAPTER VII

SUMMARY AND CONCLUSIONS

Summary

The impact of the current technological revolution, the reduction in reaction time for military commanders to make decisions, and the requirements for alternate choices in deciding courses of action in possible future wars have made it essential that Fleet Commanders be provided Cybernetic Command and Control Systems. Whether the Navy likes it or not, it is destined for a preplanned push-button mode of warfare. The Navy's success in this conceivable conflict is contingent upon how wisely information technology is utilized and cybernetic command and control is achieved.

Primarily, the Navy's approach in achieving cybernetic command and control has been in the equipment area with increased emphasis on programs and systems. To exploit this new technology for maximum Navy benefit, it is imperative that increased attention be given the "man" within the command and control complex. Therefore, the study conducted in this paper has

been directed toward the "man's" role, specifically the Fleet Commander's role in these new systems.

As discussed and reviewed earlier, command and control is not a new development. Military commanders have always devised organizations and methods to secure knowledge needed to make informed decisions. In the past as today, the human element played an important part in collecting information and making decisions. For example, the Combat Information Center of World War II collected, displayed, evaluated and presented the Commander with decision-making information; throughout this system there were many man/machine interfaces. So, as the human element was needed in the past it is needed today, and will be needed in the systems of the future. Of course, the requirement for men will be changed to some degree, since new command and control systems will relieve the Commander and his staff of some of the routine type decisions, but assuredly the prediction can be made that primary top level decisions will be made by an individual such as the Fleet Commander.

In analyzing the Fleet Commander and the command and control concept, this study revealed that the role of the Commander is two-fold: First, the role of a Naval Commander as a planner and executer of strategy and tactics; second, the role of a Naval Manager in the management control of a Cybernetic Command and Control Systems. Therefore, to handle this dual role,

the Commander must be redesigned into a highly trained specialist, who has an ingrained operational knowledge of tactical force operations combined with a thorough understanding of the management concept of cybernetics.

Because of "real-time" operations, the new approach to command and control must be the "total systems" approach. The Fleet Commander's requirements for this approach include:

1. A command and control system providing complete force control through computer analysis.

2. A general purpose, digital type computer operating "on-line--real-time" with a large scale storage and data processing capability, and wide ranging and flexible information request devices.

3. A system providing a considerable number of attack options to meet a large set of predicted military situations.

4. A provision for the Fleet Commander to be separated from the massive and complex data manipulation function to handle his decision-making functions.

5. A central data processing system consisting of input, data processing and output elements. This primary system to be the technical heart of a well-integrated command and control system.

6. Supporting subsystems which provide instantaneous input to the central computer complex. These subsystems to be part

of the total integrated system, but at the same time be capable of independent operation if any of the systems become inoperable for any reason.

7. A man/machine concept which will provide a closer relationship between the Commander and his equipment. The machine system must be organized to give and receive data from the Commander on the Commander's terms.

The data processing system and subsystems organize information into a more readily usable form, to help the Commander plan better and faster and make more knowledgeable decisions. They do not usurp the Commander's prerogatives; this system extends his intellect and amplifies his ability to handle many facts affecting decisions.

The problem areas in the development of a command and control system which will meet the Fleet Commander's requirements are as follows:

1. Communications problems. For the Fleet Commander to do his job, communications must be reliable and survivable. The solution to this problem centers on the development of communications through hardening, dispersal and redundancy. Through development in micro-electronics, size and weight are being reduced in communication equipment; and reliability and survivability are being increased. Today, it appears the solution

to communication problems is further advanced than many of the other problem areas.

2. Problems in Data Handling. This problem area is threefold, including problems in "equipment," "programs," and the development of man/machine concept. Computer technology has developed so rapidly that program and system elements in the command and control area have been unable to keep pace. Also, strategic and tactical problems must be analyzed, and systems devised before hardware can be properly developed. Substantial progress is being made in all areas of data handling, but there has been major improvement of late in programming production. There is a better understanding in the Department of Defense of the management and development aspects of this problem area. Increased emphasis is being placed on the man/machine complex by all services. An increasing understanding of decision-making as a man/machine process and other developments leading to technological improvements are receiving top priority by experts in command and control.

3. Problems in Requirements. Considerable improvement has been made in the last year in determining the requirements of systems. Commanders and those who make command and control machinery are beginning to work closer together to answer what the Commander really needs to know in a combat situation.

The problems confronting the experts in command and control loom large in the years ahead, but based on present progress, these problems will be solved.

Future improvements, according to these experts, will not be great leaps forward but modest improvements which will meet the needs of the Fleet Commander.

The impact of information technology in the business world has created implications on management which in some cases are similar to the effect on military command.

Businesses are using the principle of cybernation in information processing and management information systems. The advent of information technology on the nonmilitary scene has created many problems and changes in traditional management practices. Also, predictions indicate even more changes for corporations in the middle-management, planning and decision-making areas.

By 1970, nearly all electronic data processing systems in large corporations will be of an on-line--real-time variety. This prediction is based on a careful analysis of historical developments, present trends, basic economic pressures, and the relationship among all these factors in the field of management information systems.

Because of the introduction of information technology and cybernetics, the following analogies are listed in comparing military and nonmilitary implications:

1. It is the consensus that most scientific and business systems, especially the large ones, will become on-line--real-time operations with important man/machine aspects. Military systems represent pioneering technical efforts in information processing.

2. Both the Commander and the executive will require information by automatic techniques for decision-making. In decision-making there has been a shift of emphasis in both military and nonmilitary organizations. In the military, the shift has been from tactical decisions to strategic planning; while in business, top management stresses the strategic problems of operating corporations and shows less interest in the everyday operating problems.

3. Centralization and decentralization of decision-making can be compared between the military and nonmilitary management. The trend is toward an increasing volume of exchange throughout the chain of command in the military organization, as well as throughout the levels of the business organization. The primary reason for this increase in information flow is the growth of information processing. In both business and military, control must exist at all levels and extend from top to bottom under the concept of large multi-computer complexes.

4. The changing technology has affected both business and military management. The military commander is required to look at his planning from an entirely different view because of his need for the right information at the right time. The business manager also has to have better planning because technological revolution and scientific revolution are shortening the commercial life of his product, his company's business and industrial processes, and have increased the complexity and tightened the interrelationships of functions.

Conclusions

In reviewing the development of cybernetic command and control, and analyzing the Fleet Commander's organization, there are a number of significant implications which affect the Fleet Commander, his staff, its responsibilities, organization and decision-making processes.

The element of decision is of primary importance. Decision is recognized as the basic structure upon which Naval staffs are organized. Information processing provides the staff with a means of furnishing adequate information for the Commander in his decision-making process. Therefore, since the impact on decision-making is the most important of the implications discussed in this research report, it heads the list of the primary areas of impact:

1. Decision-making. Information processing and cybernetics have opened new possibilities in military decision-making. A Fleet Commander will have more manageable information which he can comprehend and upon which he can base sound decisions. Decisions will have more validity and speed will be attained because of instantaneous assimilation of data by means of information processing.

The recent emphasis on military command and control has resulted from the realization that information processing equipment, such as the Naval Tactical Data System, can greatly assist a Fleet Commander in making accurate and timely decisions that otherwise could not be made without considerable human effort.

Individuals properly trained and experienced in the decision-making process remain the most valuable asset in any command and control system. Therefore, the man is still the best decision maker. Computers will not take over the making of important decisions, but they may be programmed to make decisions of a routine type.

Cybernetic Command and Control Systems provide the key to effective decision, to safe and accurate weapon response and to the desired manipulation of forces by the Fleet Commander.

In the future, game theory and other operations research techniques will be used to develop operation plans and orders to provide the Commander with more accurate and newer information for decision-making purposes.

2. <u>Fleet Commander and His Staff</u>. Automation and information processing provide faster accomplishment of what used to be routine functions, many of which are beyond the capacity of human organization to manipulate available data. This capability will increase the responsiveness of command and free the Commander and his staff for broader problems.

Computers organize information into a more readily usable form, to help the Commander plan better and make faster decisions. Command and control, and communications at all levels, national as well as local, facilitate the proper response under all conditions, both strategic and tactical levels of command.

The introduction of cybernetics into the command systems will not significantly decrease the dependence of the Commander on his staff for information. Further, the computer system will be embedded in the operation, language and mission of the Fleet Commander. Computers will remove much of the menial calculation workload--providing the Commander with the much needed time for studying the situation and making decisions.

Prior to the introduction of the computer into the command and control environment, information processing was handled by the

Commander's staff. Collection and assimilation of data for operation plans was a tiresome and time-consuming effort. During training or combat operations, collection of information has been a slow process because of unreliable communications and inadequate sensing equipment. With the advent of the computer and improved communications and sensing equipment, the collection, assimilation and dissemination of information, as well as its processing, has provided a greater quantity of more timely and accurate information for the Commander's decision-making.

Within the process of providing information for the Fleet Commander, all staff functional areas have been improved due to the development of command and control systems. The Commander will be able to control detailed action in progress with more assurance because information will be of an improved quality. His command function has remained undiluted by the lengthening chain of responsibility. If the Navy expects to maintain this philosophy of command in the future it must adhere to the tested principle of centralized command with decentralized combat control at the scene of action.

3. Centralization Trend. The trend is toward centralized military control. National, political and military leaders have made it clear that the use of military forces world-wide must be centrally monitored and controlled. The primary reason is the possibility that uncontrolled action at any point could trigger

reactions escalating into a nuclear war. Therefore, in the initial conflict the Fleet Commander's responsibility in control of his forces has diminished when compared with World War II.

Since there is the possibility of nuclear war, Commanders must have decentralization as well as centralization. If the means for decentralized control did not exist, the entire structure could collapse if the center of control were destroyed. The lower level commanders must be capable of taking over command of any situation.

4. Professional Excellence. The technological revolution requires of the military officer more intelligence, more education and more expertise than ever before. The Fleet Commander and his staff must have a thorough knowledge of command and control and weapon systems under their control. The absence of such knowledge may mean defeat instead of victory.

Cybernetics and information processing are providing information for decision-making; to utilize this data the Commander and his staff must be highly trained. Today, a real challenge in the Navy is to produce the necessary professionals to handle the wars of tomorrow.

Emphasis in this study has been placed on the Fleet Commander in Cybernetic Command and Control Systems. In the past equipment programs and systems have been stressed to varying degrees, but if this nation expects to have its forces managed and

controlled effectively in peace and war, increased emphasis must be placed on the human element of command and control as well as technological areas. If the Navy and the nation fail to give adequate consideration to the man, the consequences may be disastrous in case of attack. All areas and phases must be investigated and developed to provide adequate command and control under every possible type of circumstance.

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